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January 31, 2012

Thomas Krueger, Esq.
U.S. EPA Region 5
77 West Jackson Blvd.
Chicago, IL

RE: Bofors Nobel Superfund Site, Muskegon, MI, OU II Toluene Plume

Dear Tom:

I am writing as common counsel to the Bofors Nobel Superfund Site ("the Site") Performing Settling Defendants Group ("PSD Group"). Enclosed please find a report from the PSD Group's consultant NewFields titled: "Toluene Plume Investigation Report and Extraction Well Work Plan" ("the Report and Work Plan"). The Report and Work Plan contains the data and analysis regarding the groundwater toluene plume identified on the west side of Operable Unit I ("OUI," aka Lagoon Area) of the Site, along with proposed action to contain the toluene plume OUI to prevent further migration of that plume.

The toluene plume was first identified in data from OUI piezometer PZ 111A in June 2009. Subsequent monitoring demonstrated that the toluene plume was moving south along the outside of the barrier wall, with little or no lateral movement to the west. Data collected using membrane interface probes technology ("MIP") in October 2011 confirmed that the toluene plume is a very discrete plume, both vertically and horizontally; those data are included in the enclosed Report and Work Plan. The data unequivocally identified Site Operable Unit II ("OUII," aka the former Lomac facility) as the source of the toluene plume. Preliminary discussions with US EPA and MDEQ ("the Agencies") regarding the MIP data confirmed that there is no dispute regarding the source of the toluene plume being Site OUII.

Under the terms of the settlement agreements executed between the Agencies and the PSD Group, the PSD Group is responsible only for

Site OUI, including groundwater on OUI. The PSD Group has included in the enclosed Report and Work Plan its proposed actions to contain the toluene plume on OUI and prevent off-Site migration of the toluene plume. However, the MIPs data demonstrate that the source of the toluene plume is Site OUII, and that the Site OUII source or sources continue to leach toluene and other contaminants into the groundwater. Site OUII is the responsibility of the Agencies under the terms of the settlement agreements. Continued leaching of contaminants into the groundwater from Site OUII where they will migrate onto Site OUI is causing and will continue to cause the PSD Group to incur Superfund response costs.

The PSD Group requests that the Agencies advise it as soon as is feasible of what actions the Agencies plan to take to control the Site OUII source(s) of the toluene plume. As the Agencies are well aware, source control is a key component of all Superfund response actions. Source control may impact the OUI plume control actions that the PSD Group is taking. The PSD Group looks forward to coordinating response actions regarding the toluene plume with the Agencies.

Please do not hesitate to contact me with any questions or responses regarding this issue. Technical questions or responses should be sent directly to the PSD Group's project coordinator, Jim Campbell.

Very sincerely yours,

Jerome I. Maynard

cc: J. Fagiolo, US EPA
W. Wagaw, MDEQ

Toluene Plume Investigation Report and Extraction Well Work Plan

for the Bofors-Nobel Superfund Site

January 31, 2011

NEWFIELDS

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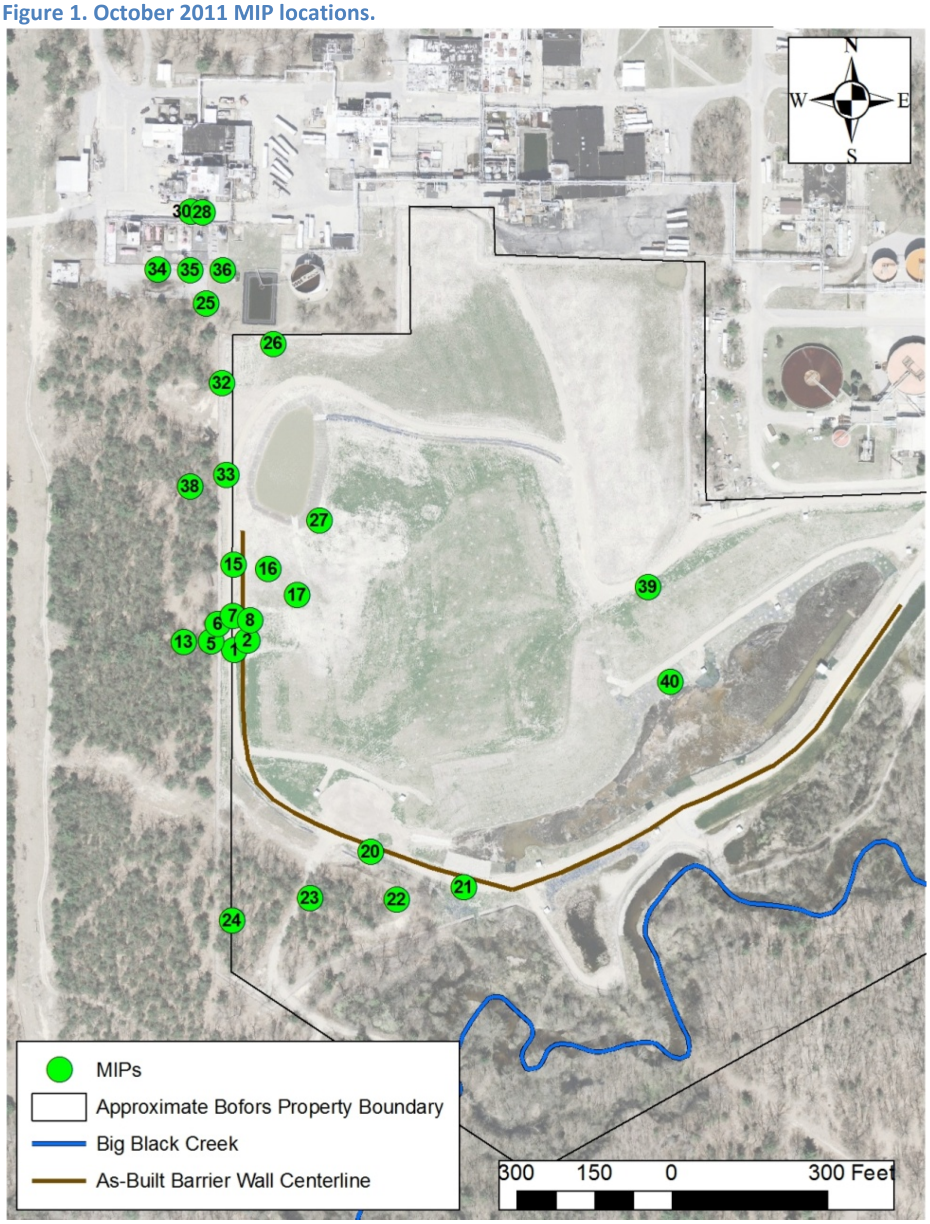
1 Introduction

In October 2011, membrane interface probes (MIP) were used to determine the location of a toluene plume on the west side of the Bofors-Nobel Superfund Site (the Site). Nineteen MIP locations were planned in the July 2011 PZ-111A Phase 2 Investigation Work Plan (the Work Plan). In the August 2011 Bofors-Nobel PRP Group Response to US EPA Comments, six additional MIP locations were added for a total of 25 planned MIP locations. Due to the real-time nature of MIP results, many of the planned MIP locations were revised and new locations were added during phone calls with the EPA and MDEQ during the course of the performance of the field work. In total, 28 MIPs were advanced, and their locations are shown in Figure 1.

Figure 1. October 2011 MIP locations.



The MIPs measured electrical conductivity, rate of push, minimum and maximum temperature and back pressure every 0.05 feet. Also measured every 0.05 feet are the minimum and maximum results, in millivolts, of a photo-ionization detector (PID), a flame ionization detector (FID), and an electron capture detector (ECD).

2 Field Investigation

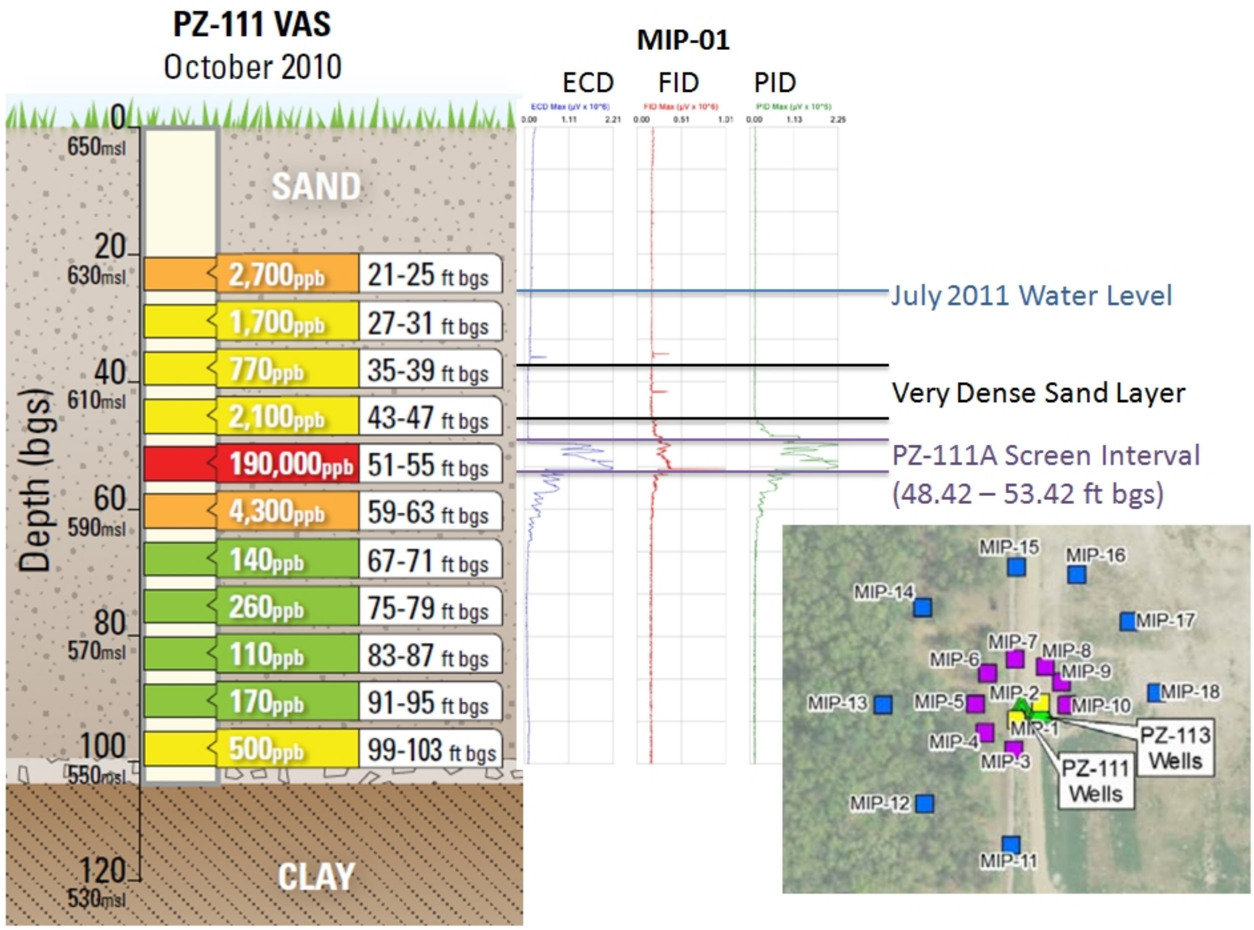
A phased approach was proposed for the field investigation. The first phase utilized MIP technology to look for possible toluene sources and migration routes. Several existing monitoring wells were also sampled as part of this field investigation. Conference calls with the EPA and MDEQ were held during the work to gain concurrence on next steps and investigation locations.

2.1 Membrane Interface Probes

MIP technology utilizes real time analysis of vapors generated by advancing a heated probe at the end of a geoprobe drilling rod. The heat volatilizes organic compounds which pass through a permeable membrane into a carrier gas for analysis using detectors located on a support vehicle adjacent to the geoprobe rig. The FID is used to detect aliphatic compounds. The ECD is used to detect halogens. The PID is used to detect aromatic compounds and effectively has a detection limit of 1 part per million (ppm) for total VOCs. This detection limit is sufficient for source delineation and high mass migration given the levels of toluene detected at PZ-111A since June 2009 (up to 340 ppm). Further details on this technology were provided in July 2011 PZ-111A Phase 2 Investigation Work Plan.

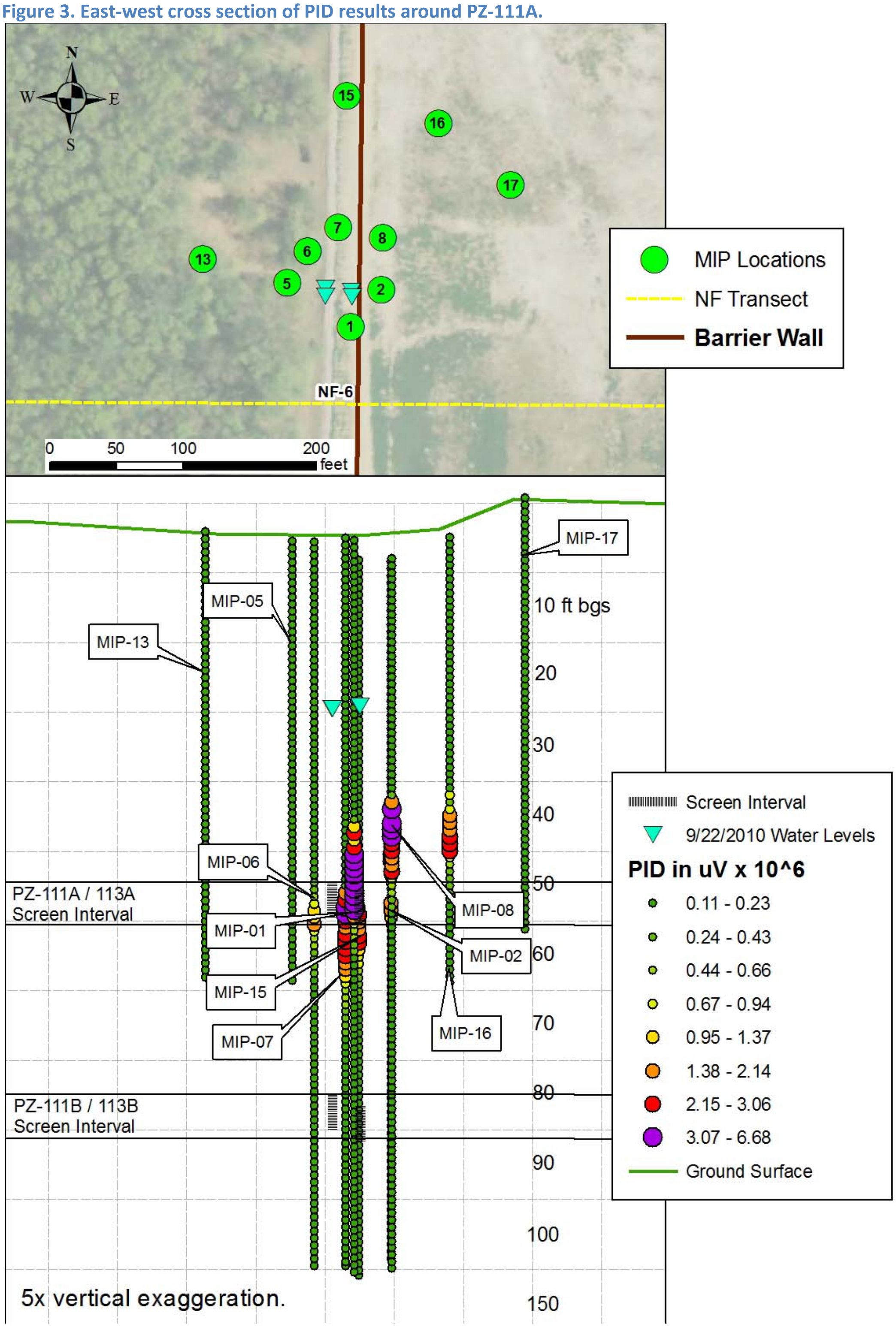
The MIP phase of work took place from September 19, 2011 through October 11, 2011. To calibrate the MIP, a MIP boring was advanced directly next to the location of PZ-111-VAS prior to beginning delineation work. The MIP readings are compared to the laboratory results obtained from the VAS boring in Figure 2. This figure shows that MIP and VAS results are well correlated at toluene concentrations above 1 ppm. This data demonstrates the validity of the MIP approach. The MIP also allowed the detection of a very dense sand layer which likely explains the presence of the toluene spike about 20 feet below the water table. This very dense or cemented layer (also called the "hard pan") was not detected during previous vertical aquifer sampling using a hollow stem auger drilling method.

Figure 2. Comparison of MIP-01 to PZ-111-VAS toluene results.



Following the calibration borings, several layers of MIP borings were installed around PZ-111A which allowed the delineation of the width of the toluene plume. Figure 3 shows the cross-sectional view of the PID results, which demonstrated that the toluene is traveling in a narrow band along the barrier wall.

Figure 3. East-west cross section of PID results around PZ-111A.



Once the narrow width of the plume was established, it was agreed during conference calls with the EPA and MDEQ that identifying the source of the toluene plume was the next priority. As such, installation of remaining planned MIPs around PZ-111A was deemed unnecessary.

Therefore, additional MIPs were advanced in suspected source areas in OU2, i.e., south of the former tank farm and south of Building 5 on the Lomac property. These borings showed that the toluene source appears to be the former tank farm on the Lomac property. Additional MIPs were then placed in between the former tank farm and PZ-111A to verify the plume pathway and width. Figures 4 and 5 show these results. The former tank farm area appears to be the toluene source. The data show that the toluene plume remains under the hard pan sand layer as it moves downgradient. The data show that toluene concentrations decrease in the area between the tank farm and PZ-111A and then increase near PZ-111A, suggesting that toluene was released in pulses or that the MIP borings were slightly off the center line of the plume.

Figure 4. North-south cross section of PID results.

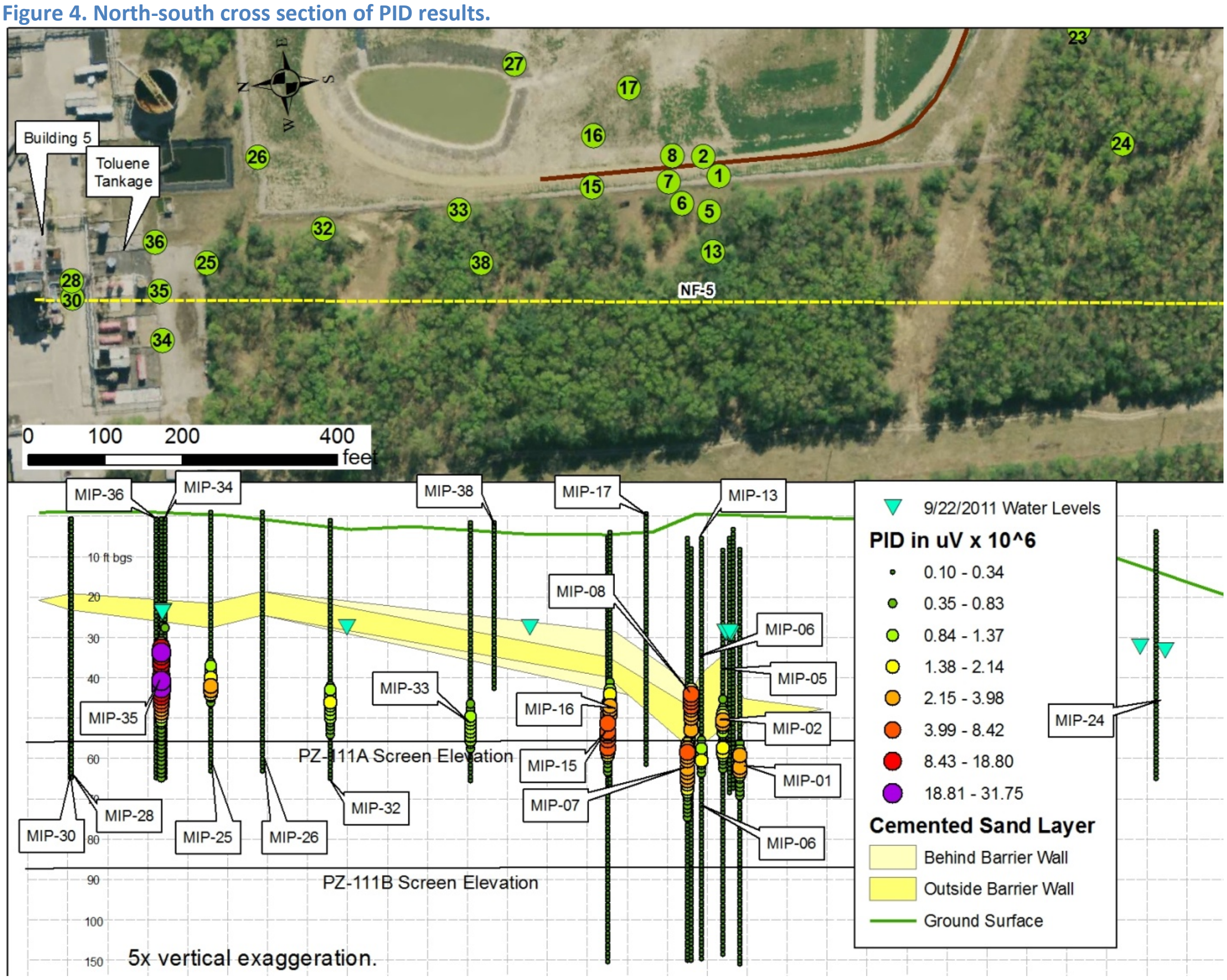
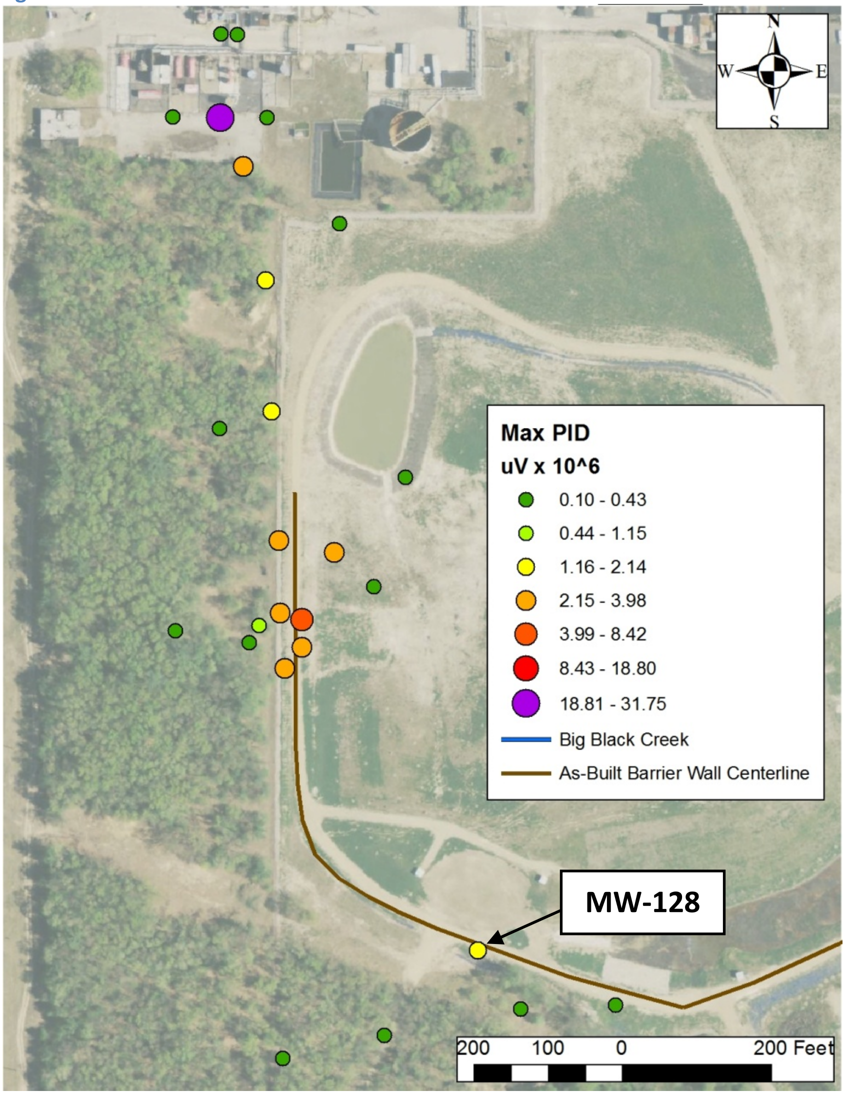


Figure 5. Aerial view of maximum PID results.



Additional MIPs were advanced south of the barrier wall to determine whether and how far the plume had travelled downgradient and to confirm that existing well screens in this area are at the appropriate elevation. PID detections above background levels were only observed near the MW-128 well cluster, where high toluene concentrations have previously been detected in MW-128B. The screen in MW-128B was found to be at the appropriate elevation.

MIP borings were initially installed from ground surface to the clay till in accordance with the Work Plan. However, after results consistently showed that PID detections were not observed deeper than 60 feet below ground surface, it was agreed on a September 26, 2011 conference call with the EPA and MDEQ that subsequent MIPs would not be advanced below 65 ft bgs. The GeoProbe® and MIP equipment were decontaminated between each boring in accordance with the Work Plan.

The final report of the MIP results from Columbia Technologies is Appendix A. NewFields MIP investigation field notes are in Appendix B.

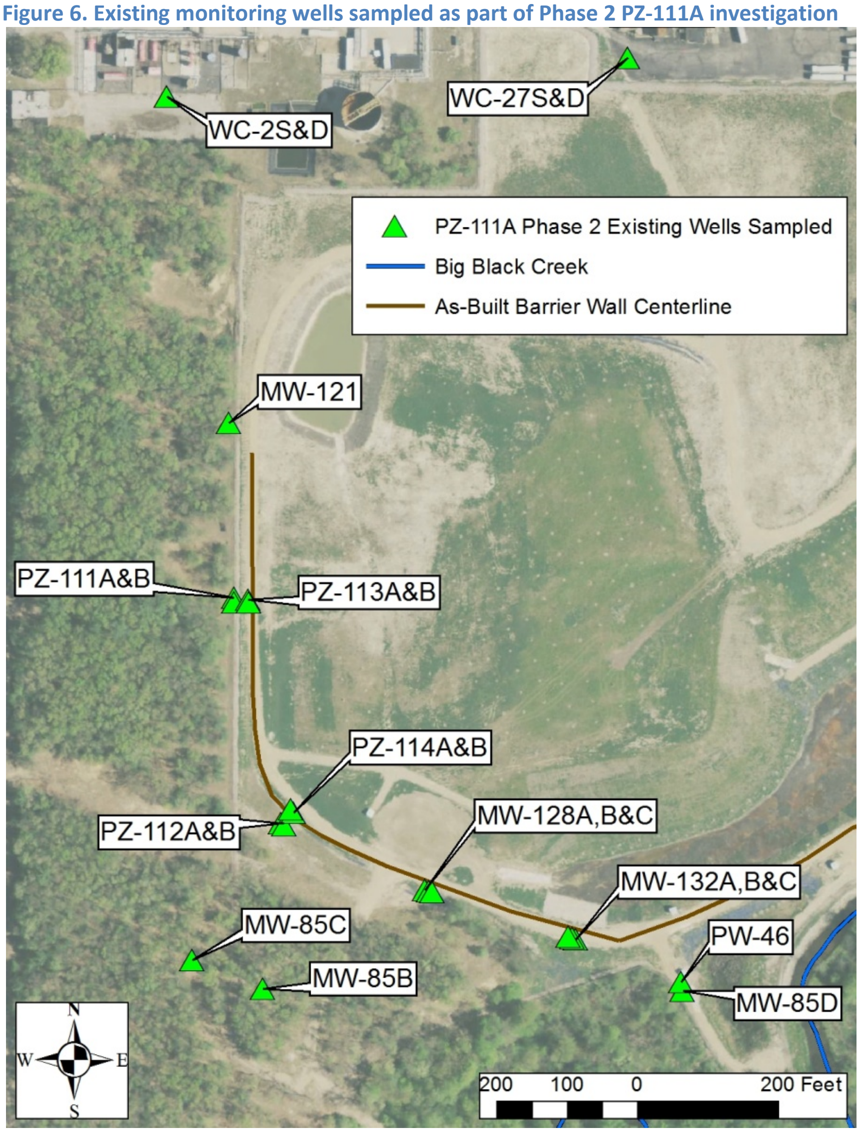
2.2 Monitoring Well Redevelopment

Existing wells WC-27D and WC-27S were redeveloped on October 6 and 7, 2011, respectively, and were not sampled until October 26th to allow at least 14 days between redevelopment and sampling. The MIP field notes in Appendix B contain the record of the well redevelopment.

2.3 Existing Monitoring Well Sampling

Several existing wells were sampled during the October 2011 interim monitoring event in order to advance the toluene plume investigation (Figure 6). The results for sampling of existing wells are included as an appendix to the Report of Results - Interim Monitoring - October 2011.

Figure 6. Existing monitoring wells sampled as part of Phase 2 PZ-111A investigation



2.3.1 Toluene

The toluene results from the October 2011 sampling event, which took place from October 17 through October 27, are presented in aerial view in Figure 7. Figure 8 presents the cross-sectional view of these results, along with the toluene concentrations.

Figure 7. Plan view of October 2011 toluene results.

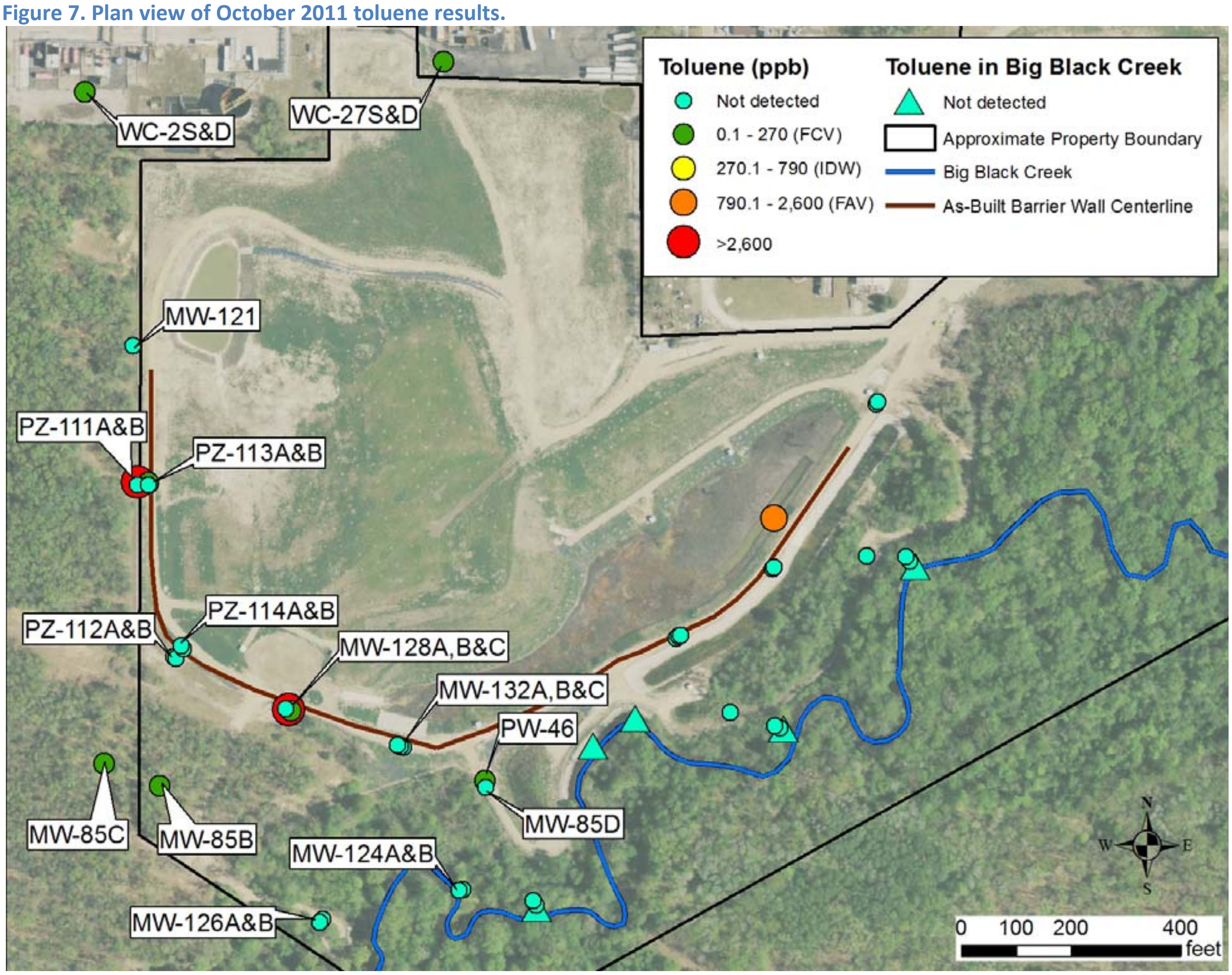
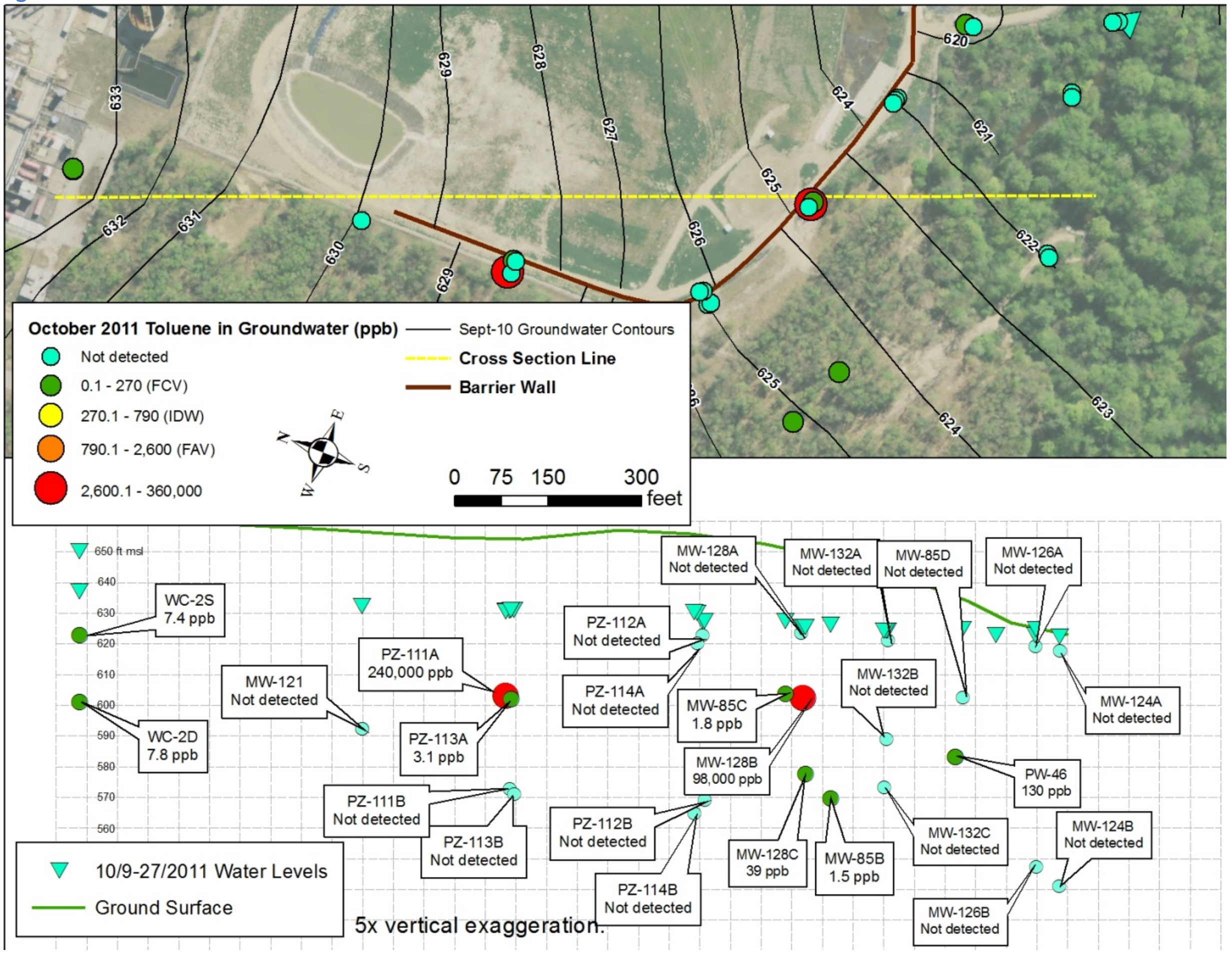


Figure 8 is rotated 70 degrees counter-clockwise in order to show the toluene results along a cross section that runs from the WC-2 well cluster to between the MW-126 and MW-124 well clusters.

Figure 8. Cross-sectional view of October 2011 toluene results.



Toluene appears in pumping well PW-46, which is in line with the direction of groundwater flow, below the Rule 57 Final Chronic Value (FCV). The data indicate that well PW-46 will be effective in capturing toluene in this portion of the Site. Wells MW-85B and C also contained toluene at levels that would not have been detected by the MIP borings: 1.5 and 1.8 ppb, respectively. The presence of toluene in these wells indicates the possibility of some lateral dispersion along the flow path of the toluene (shown on Figure 5). However, the concentrations are much higher along the Barrier Wall flowing toward PW-46. This indicates that the toluene mass is migrating towards extraction well PW-46.

It is unlikely that the concentration of toluene in well MW-85C (1.8 ppb) will exceed the property boundary POC standard of 790 ppb for the following reasons:

- The distance between PZ-111A and MW-85C is approximately equal to the distance between PZ-111A and MW-128B
- MW-85C, MW-128B and PZ-111A are all screened at approximately the same elevation

- Two years after a toluene detection of 200,000 ppb in PZ-111A, a toluene detection of 180,000 ppb occurred in MW-128B
- It has taken almost 2.5 years for toluene to appear in MW-85C, and the concentration is 1.8 ppb

If MW-85C were in the direct flow-path of the toluene plume, a much higher toluene concentration would have been detected by now. Instead, the toluene in MW-85C appears to be the result of lateral dispersion from the centerline of the flow-path, and the contaminant will not have the same impact at this well as it has on wells in the direct flow-path; the MIP data has shown us that the plume width is only 50 feet, and outside of this lateral distance there were no detections above 1,000 ppb total VOCs (or they would have been detected by the PID).

2.3.2 Tentatively Identified Compounds

The wells sampled as part of the PZ-111A toluene plume analysis were also tested for a list of tentatively identified compounds in Table 1. These compounds are thought to be associated with the OU2 area. Only one of the compounds, dipropylamine, was observed in any of the wells. This compound appeared only in well WC-2S, which is in OU2 (shown in Figure 7), and estimated at a concentration of 0.7 ppb. Because of the low concentration and lack of detections of these compounds in OU2, these compounds do not appear to be associated with the toluene plume.

Table 1. Tentatively identified compounds

2-Amino-5-Chlorotoluene Sulfonic Acid
2-Chloro-4-Aminotoluene
4-methyl-Benzenamine (p-Toluidine)
Dipropylamine
Dipropylamine
N,N-Dimethylformamide
Phosphorus Oxytrichloride
Tetranitromethane

3 Proposed Additional Work

An extraction well is proposed near the bend in the barrier wall to contain the toluene plume until groundwater concentrations decline sufficiently after EPA addresses the source material as part of OU2. Collecting groundwater at this location will also prevent additional mass from migrating southwest away from the Barrier Wall. Vertical aquifer sampling (VAS) will be performed at the proposed location of the new extraction well, in order to collect a soil sample and determine the appropriate screen interval.

3.1 Vertical Aquifer Sampling

The SOP for VAS is included in Appendix C. During the VAS, groundwater samples will be collected every 8 feet from the water table to the top of the till and analyzed for VOCs. Split-spoon soil samples will be collected continuously from ground surface to the top of the till. The split-spoon soil samples collected at the capillary fringe, in the first several feet of the saturated zone and in the interval of the highest suspected toluene concentration (assumed to correspond with the interval of highest PID results at the nearest MIP borings) will be tested for the presence of light non-aqueous phase liquid (LNAPL) using Sudan IV dye. An SOP for Sudan IV Dye testing is included in Appendix C. In addition, a portion of each split-spoon sample collected throughout the assumed screened interval of the extraction well (assumed to be 45 feet to 65 feet below ground surface (bgs)) will be collected in a gallon baggie and evaluated for grain size analysis to assist in determining the proper screen slot size and filter pack size for the proposed pumping well to be installed in that location. The VAS must be performed with a Geoprobe, and not with an auger, because the auger method is not sensitive enough to detect the hard pan layer, and the Geoprobe method provides less opportunity for vertical smearing (samples are collected from the top down using Geoprobe, and from the bottom up using auger).

3.2 Extraction Well Installation

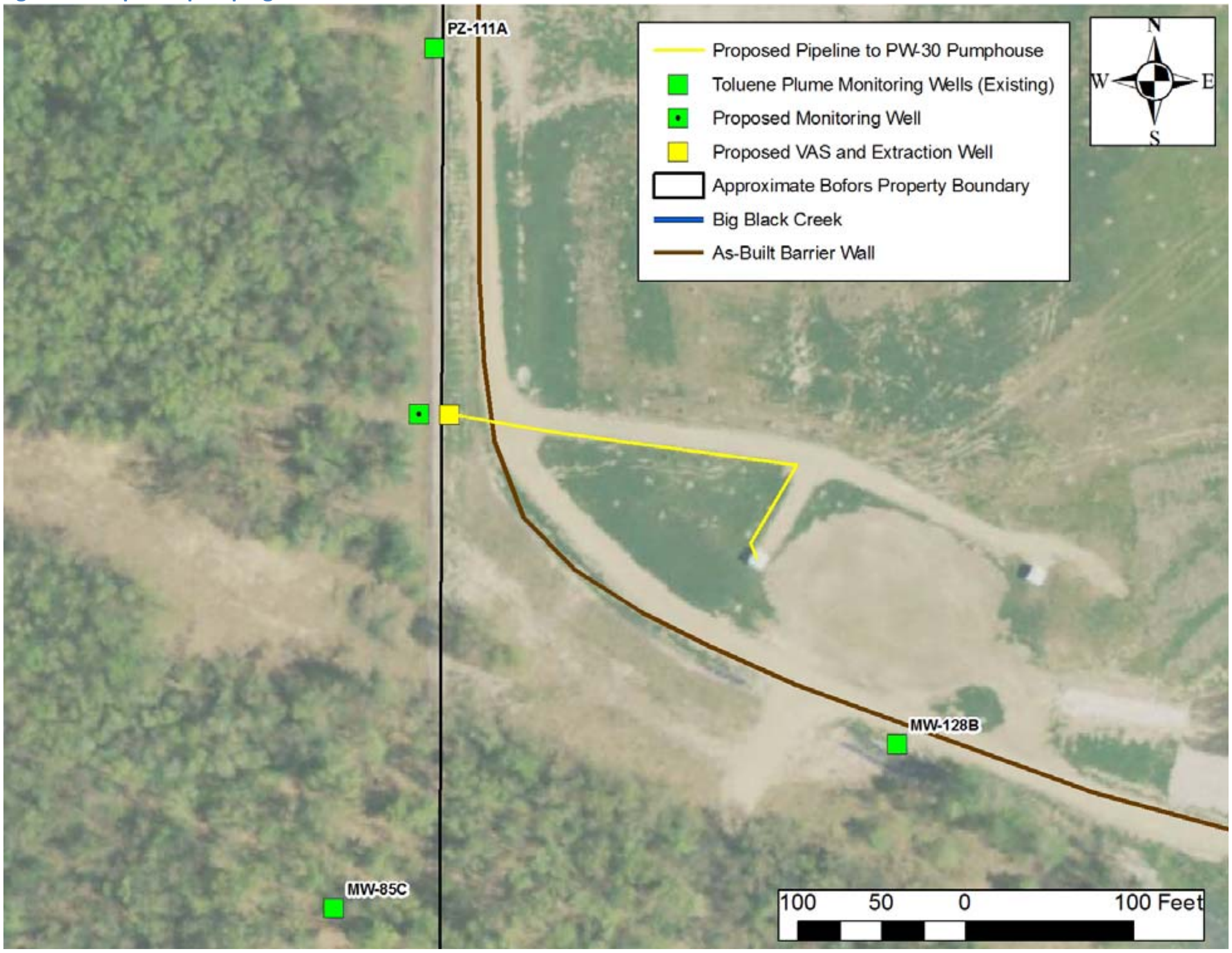
An extraction well will be installed near the western bend in the barrier wall, as shown on Figure 9, to pump at an estimated 10-20 gallons per minute (gpm) in order to contain the toluene plume. The well will be installed to an approximate depth of 60 feet bgs and screened below the hard pan layer, from approximately 50 to 60 feet bgs. The actual screened interval may be modified pending results of the VAS. The extraction well will be eight inches in diameter and the screen slot size and filter pack size will be determined subsequent to grain size analysis of the soil samples collected during the VAS activities. The screen will be stainless steel attached to a segment of galvanized riser pipe.

The extraction well placement is anticipated to catch the plume just before the flow direction changes to the southeast and to prevent dispersion from allowing mass to move to the southwest. Wells MW-128B and MW-85C are far enough downgradient from the extraction well as to be outside of the area of influence and will be able to serve as monitoring wells to determine whether the plume has been or is being sufficiently removed.

The anticipated pumping rate of 10-20 gpm is based on the fact that the plume is very narrow laterally (approximate 30-foot width – see Figures 3 and 5) and very thin vertically (approximately 10 feet in thickness at PZ-111A – see Figures 3 and 4). The 10-20 gpm estimate also assumes that a well very near the barrier wall would have an advantage in developing greater drawdown/capture. The extraction well will be placed between the barrier wall and the site fence. A monitoring well will be installed 15 feet due west of the extraction well. This monitoring well will be screened at the same level as the maximum toluene concentration depth interval and will be sampled quarterly (water level and VOCs) to shown that extraction is capturing the width of the toluene plume and to monitoring toluene levels. During initial operation, the pumping rate will be adjusted based on the monitoring well's water level to achieve the necessary plume capture. The SOP for Monitoring Well Installation and Development is located in Appendix C.

The extraction well will be installed and developed in accordance with the Extraction Well Construction and Development SOP included in Appendix C. The pump to be installed in the new extraction well will be a 1 horsepower Grundfos 25S10-7 stainless steel pump. The extracted groundwater will be conveyed by a high density polyethylene pipe (HDPE) to the PW-30 pump house (see Figure 9) where it will be discharged to the existing groundwater transmission line for treatment at the groundwater treatment plant. The pipeline will cross the barrier wall at the location of the new pumping well, which is approximately 8 feet below ground surface at that location, according to as-built drawings. Samples will be collected from the newly installed well at least 14 days after development and will be analyzed for VOCs.

Figure 9. Proposed pumping well and VAS locations.



4 Schedule for Work

NewFields plans to subcontract with a drilling company to mobilize a rig to the site within four weeks of authorization of this Work Plan (contingent upon the availability of a driller). Therefore, the proposed schedule for fieldwork is as follows:

- Field work
  - VAS (one week of fieldwork)
  - Extraction well and piezometer installation (including piping to PW-30) – (approximately 3 to 4 weeks after completion of VAS)
  - Sampling of new pumping well – 14 days after installation
- Laboratory data (four weeks after sampling)
- Data analysis and as-built report (45 days from receipt of final laboratory data)

Appendix A: Columbia Technologies MIP Report

SmartData Solutions®

Subsurface Characterization Using Membrane Interface Probe (MIP) and Soil Conductivity (SC) Technologies
Bofers Nobel
5307 Evanston Avenue
Muskegon, Michigan

PREPARED FOR

NewFields
1349 West Peachtree Street
Suite 2000
Atlanta Georgia, 30309

October 18, 2011

PREPARED BY

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APPENDICES

Introduction

NewFields (NewFields) contracted **COLUMBIA Technologies, LLC (COLUMBIA)** to conduct an investigation of subsurface contamination at the Bofers Nobel site, located in Muskegon, Michigan. This investigation involved delineating the depth and horizontal extent of total volatile organic compound (VOC) contamination distribution, including dissolved phase, vapor phase and sorbed phase, using Membrane Interface Probe (MIP) technology and characterizing soil electrical conductivity using Soil Conductivity (SC) technology.

The investigation was conducted September 19, 2011 through October 11, 2011, and consisted of 28 MIP/SC locations to depths ranging from 42.65 feet to 106.15 feet below ground surface (bgs). A Geoprobe® Direct Push Technology (DPT) drilling rig was used to advance the locations.

Objectives

The objectives of the MIP/SC investigation were to:

- Delineate in high resolution the vertical and horizontal extent of the total VOC contamination distribution, including dissolved phase, vapor phase and sorbed phase, throughout the investigation area as well as detailed information concerning soil electrical conductivity properties.

MIP/SC Equipment Description

The MIP/SC probe is approximately 12-inches (30 cm) in length and 1.5-inches (3.8 cm) in diameter. The probe is driven into the ground at the nominal rate of one foot per minute using a DPT rig.

Soil conductivity, the inverse of soil resistivity, is measured using a dipole arrangement. In this process, an alternating electrical current is transmitted through the soil from the center, isolated pin of the probe. This current is then passed back to the probe body. The voltage response of the imposed current to the soil is measured across these same two points. Conductivity is measured in Siemens/meter, and due to the low conductivity of earth materials, the SC probe uses milliSiemens/meter (mS/m). The probe is reasonably accurate in the range of 5 to 400 mS/m. In general, at a given location, lower conductivity values are generally characteristic of larger particles such as sands, while higher conductivities are characteristic of finer sized particles such as silts and clays.

The MIP portion of the probe was developed and patented by Geoprobe Systems, Inc. The operating principle is based on heating the soil and/or water around a semi-permeable polymer membrane to 121ºC, which allows VOCs to partition across this membrane. The MIP can be used in saturated or unsaturated soils, as water does not pass through the membrane. Nitrogen is used as an inert carrier gas, and travels from a surface supply down a transfer tubing which sweeps across the back of the membrane and returns any captured VOCs to the installed detectors at the surface. It takes approximately 37 seconds for the nitrogen gas stream to travel through 100 feet of inert tubing and reach the detectors.

COLUMBIA utilizes three detectors: a Photo Ionization Detector (PID), a Flame Ionization Detector (FID) and an Electron Capture Detector (ECD), mounted on a laboratory grade Shimadzu Model 14A gas chromatograph. The output signal from the detectors is captured by a MIP data logging system installed on a MIP Field Computer or laptop computer. Conductivity, speed, detector data and temperature are displayed continuously in real time during each push of the probe.

The PID detector consists of a special UV lamp mounted on a thermostatically controlled, low volume, flow-through cell. The temperature is adjustable from ambient temperature to 250ºC. The 10.2 electron volt (eV) UV lamp emits energy at a wavelength of 120 nanometers, which is sufficient to ionize most aromatics (benzene, toluene, xylene, etc.) and many other molecules (e.g. H_2S, hexane, ethanol) whose ionization potential is below 10.2 eV. The PID also emits a lower response for chlorinated compounds such as TCE and PCE. Methanol and water, which have ionization potentials greater than 10.2 eV, do not respond on the PID. Detection limits for aromatics are in the low picogram range of the detector. Since the PID is non-destructive, it is often run first in series with other detectors for multiple analyses from a single injection. Use of the PID is mandated in several EPA methods (8021, TO-14 etc.) because of its sensitivity and selectivity.

The most commonly used GC detector is the FID, which responds linearly over several orders of magnitude from its minimum detectable quantity of about 100 picograms. The FID response is very stable from day to day. This detector responds to any molecule with a carbon-hydrogen bond, but poorly to compounds, such as H_2S, CCl_4, or NH_3. The carrier gas effluent from the GC column is mixed with hydrogen and burned. Hydrogen supports a flame and ionizes the analyte molecules. A collector electrode attracts the negative ions to the electrometer amplifier, producing an analog signal, which is directed to the data system input.

The ECD detector consists of a sealed stainless steel cylinder containing radioactive Nickel-63. The Nickel-63 emits beta particles (electrons), which collide with the carrier gas molecules, ionizing them in the process. This forms a stable cloud of free electrons in the ECD cell. When electro-negative compounds (especially chlorinated, fluorinated or brominated molecules), such as carbon tetrachloride or TCE, enter the cell, they immediately combine with the free electrons, temporarily reducing the number remaining in the electron cloud. The detector electronics, which maintain a constant current of about 1 nanoampere through the electron cloud, are forced to pulse at a faster rate to compensate for the decreased number of free electrons. The pulse rate is converted to an analog output, which is transmitted to the data system.

MIP System Performance Test

As a quality control check, the MIP system response is evaluated prior to and upon completion of each MIP location. An aqueous phase performance test is performed using specific compounds designed to evaluate the sensitivity of the particular probe, transfer line and detector suite to be used. The resulting values are recorded and compared to predetermined values.

Investigation Methods

A total of 28 MIP/SC locations were completed at the Bofers Nobel site. Each location was selected by NewFields' representative onsite, and the termination depth of each location was also determined by NewFields' representative onsite. Immediately upon completion of each location, the dataset is wirelessly delivered to **COLUMBIA's** remote servers for Quality Assurance/Quality Control (QA/QC) review and upload to a password secure website using Columbia's patented ***SmartData Solutions***® technology. The results from each location are shown in Appendices A and B.

MIP/SC Log Interpretation

Each MIP/SC log includes six separate graphs of data. The first graph displays the temperature of the probe as it is advanced in the subsurface. This graph can be useful to determine where groundwater is encountered. The next three graphs are measures of chemical detector response: ECD, FID, and PID, measured in microvolts (uV). These graphs are a linear scale, and give relative concentrations of contamination. The fifth graph is the rate of penetration (speed of the probe) and is measured in feet/min. This information can be used to determine how resistant the subsurface is to the direct push and/or percussion. The last graph is soil electrical conductivity and is measured in mS/m. In general, lower conductivities are indicative of coarser grained particles, such as sands and silty sands, and higher conductivities are indicative of finer grained particles, such as clays and silty clays.

Correlating MIP Results to Sampling or Laboratory Analyses

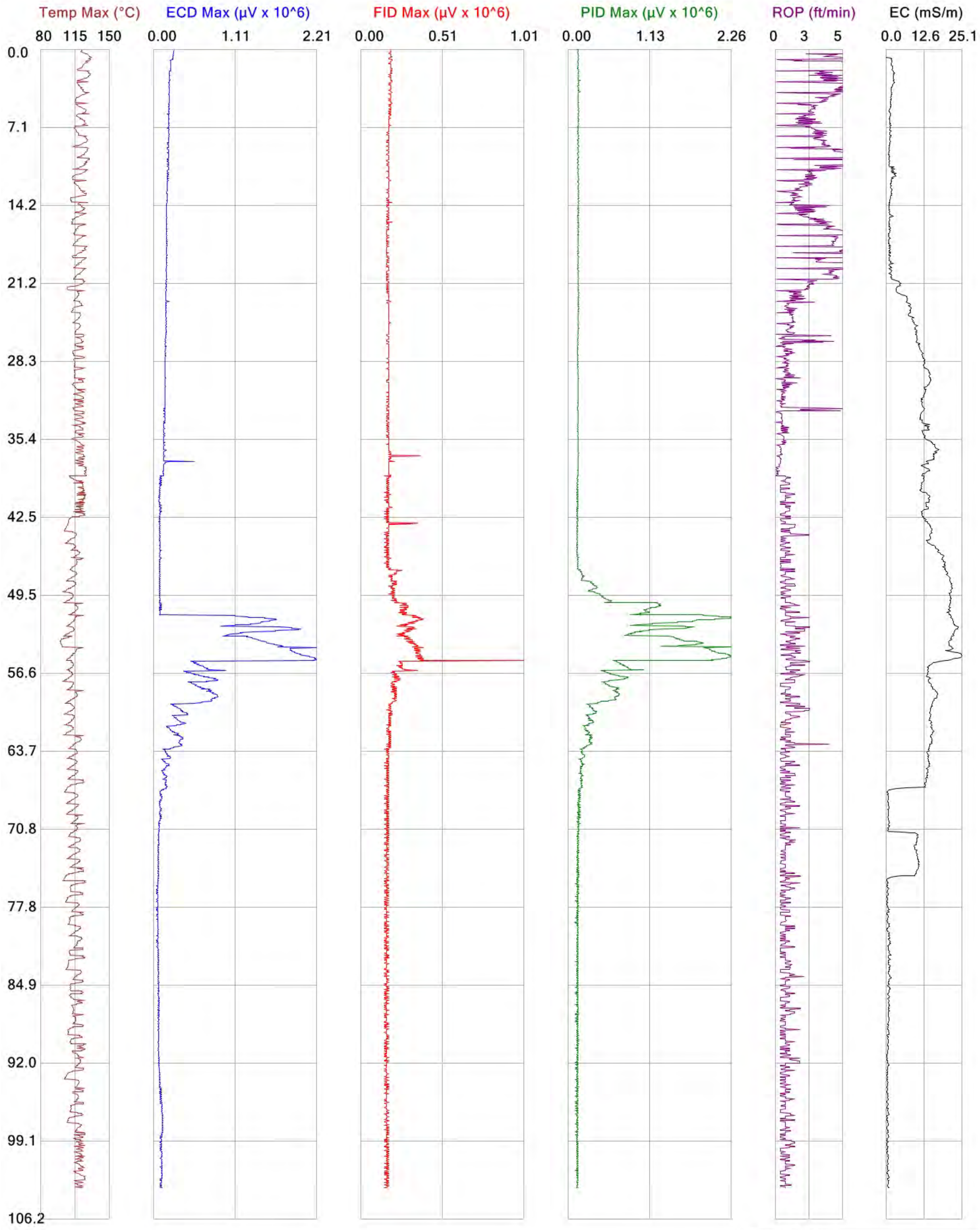
Generalized correlations between MIP response and laboratory sample results can be inferred, but cannot be viewed as a linear comparison. MIP response and laboratory results are collected, analyzed and reported in different units and by different procedures, so correlation is not an exact one-to-one comparison. The MIP process uses a membrane extraction process from a heated zone of varying subsurface matrix of soil, water, and/or vapor. Soil and groundwater results involve the collection of a sample, extraction of a sub-sample at the surface, and then transporting them to a laboratory for further extraction and analysis. These two processes are different by definition.

SmartData Solutions® is a registered trademark of COLUMBIA Technologies LLC.

Geoprobe® is a registered trademark of Geoprobe Systems, Inc.

APPENDIX A

MIP Logs (Individual Scale)



COLUMBIA TECHNOLOGIES

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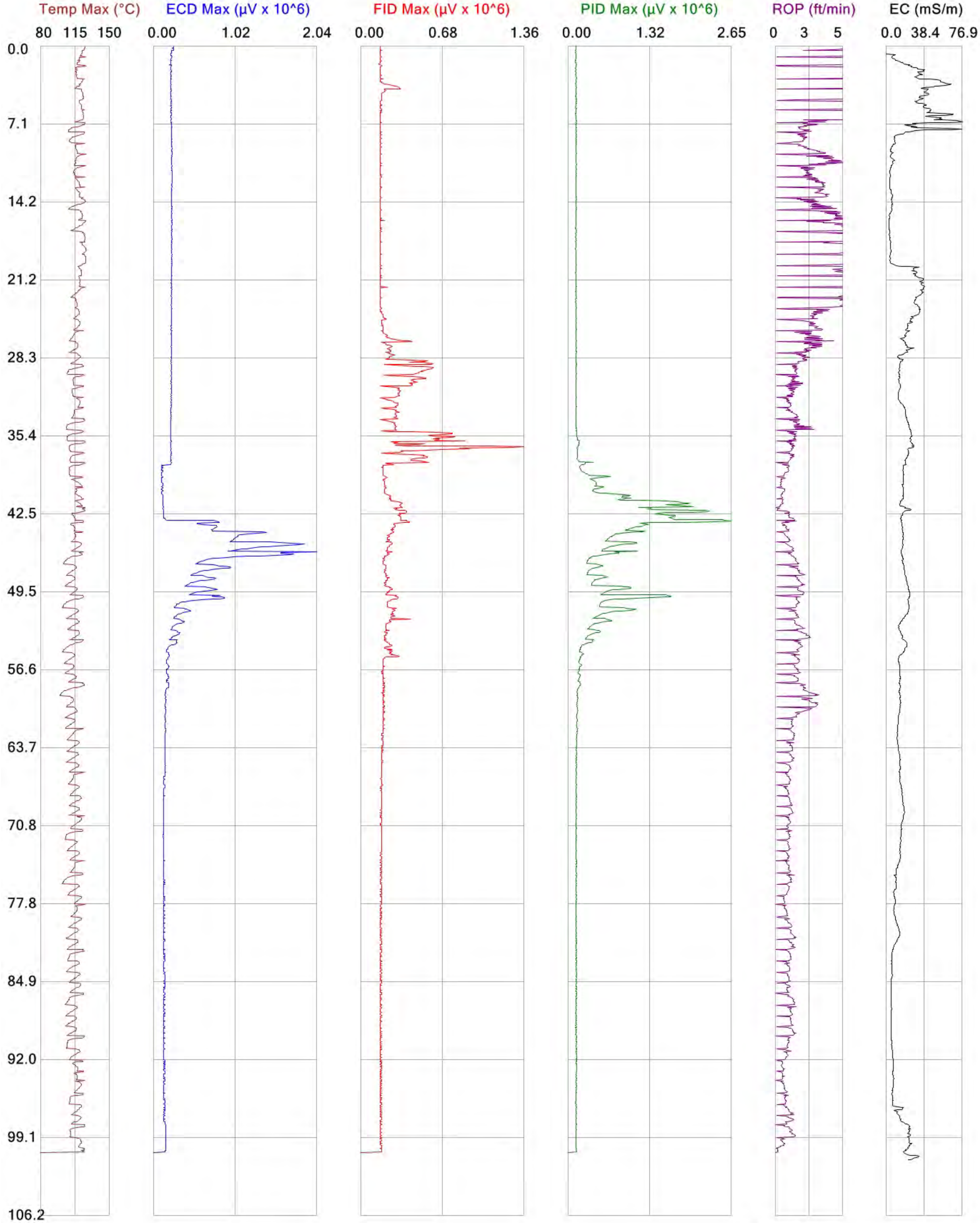

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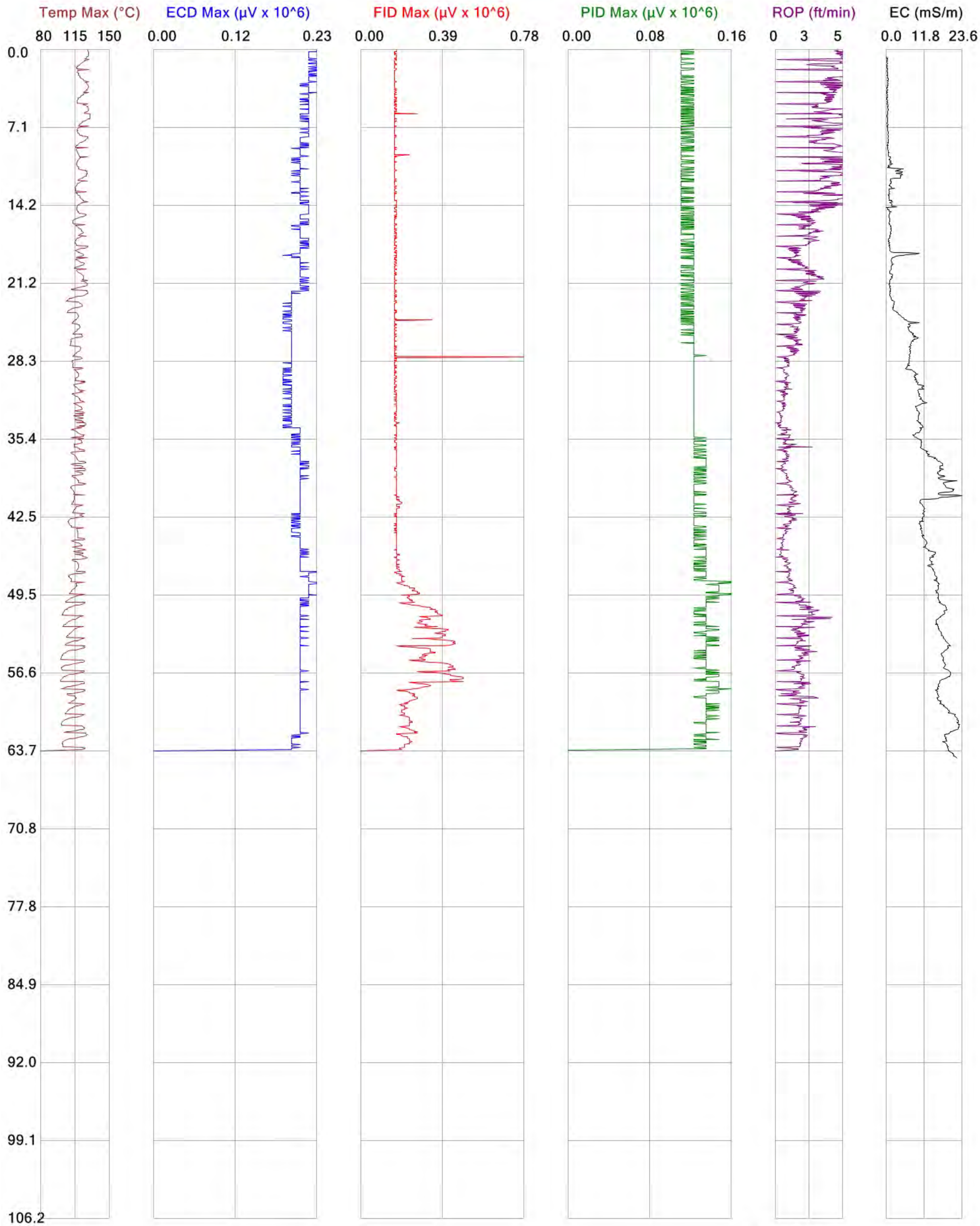

COLUMBIA TECHNOLOGIES

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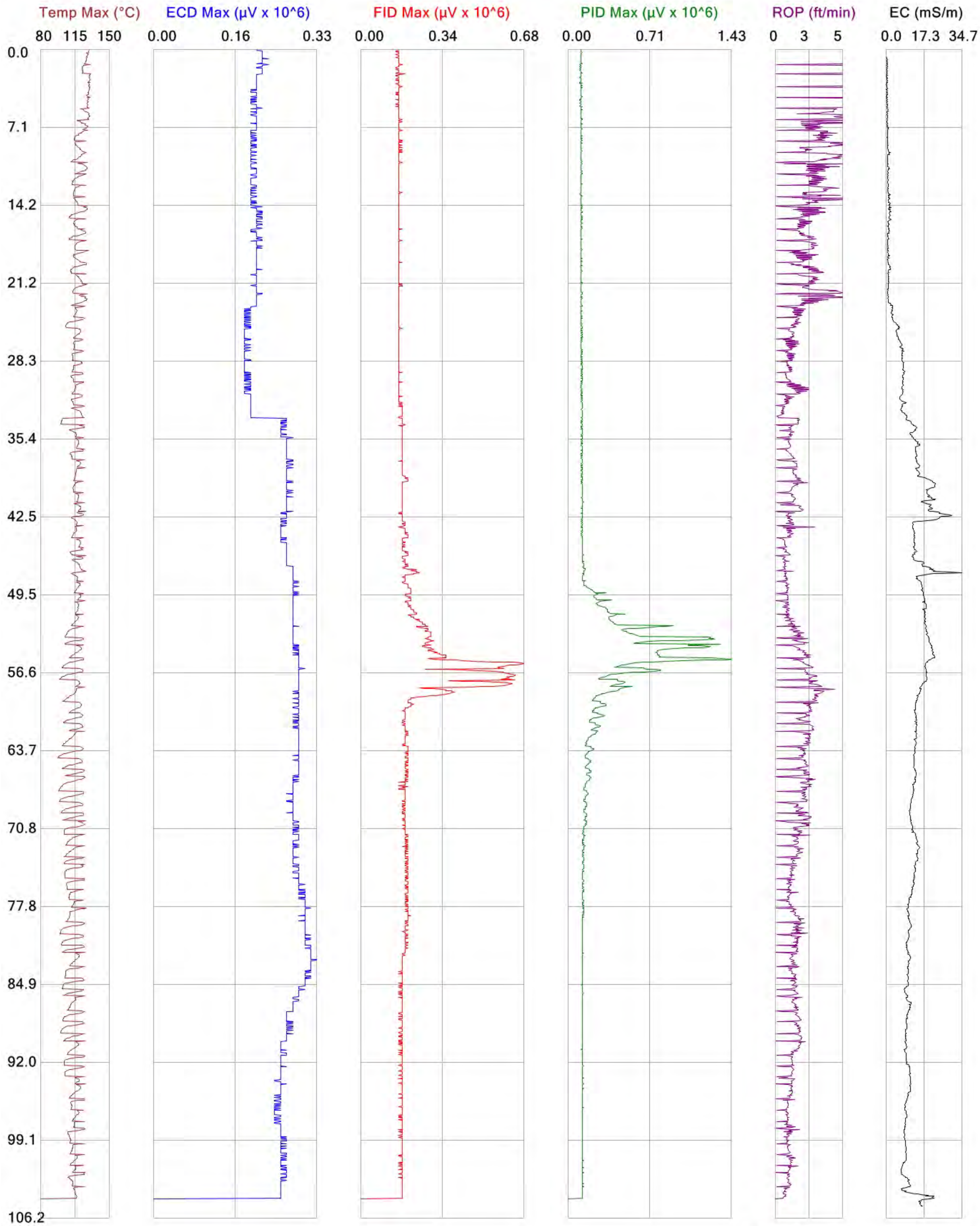

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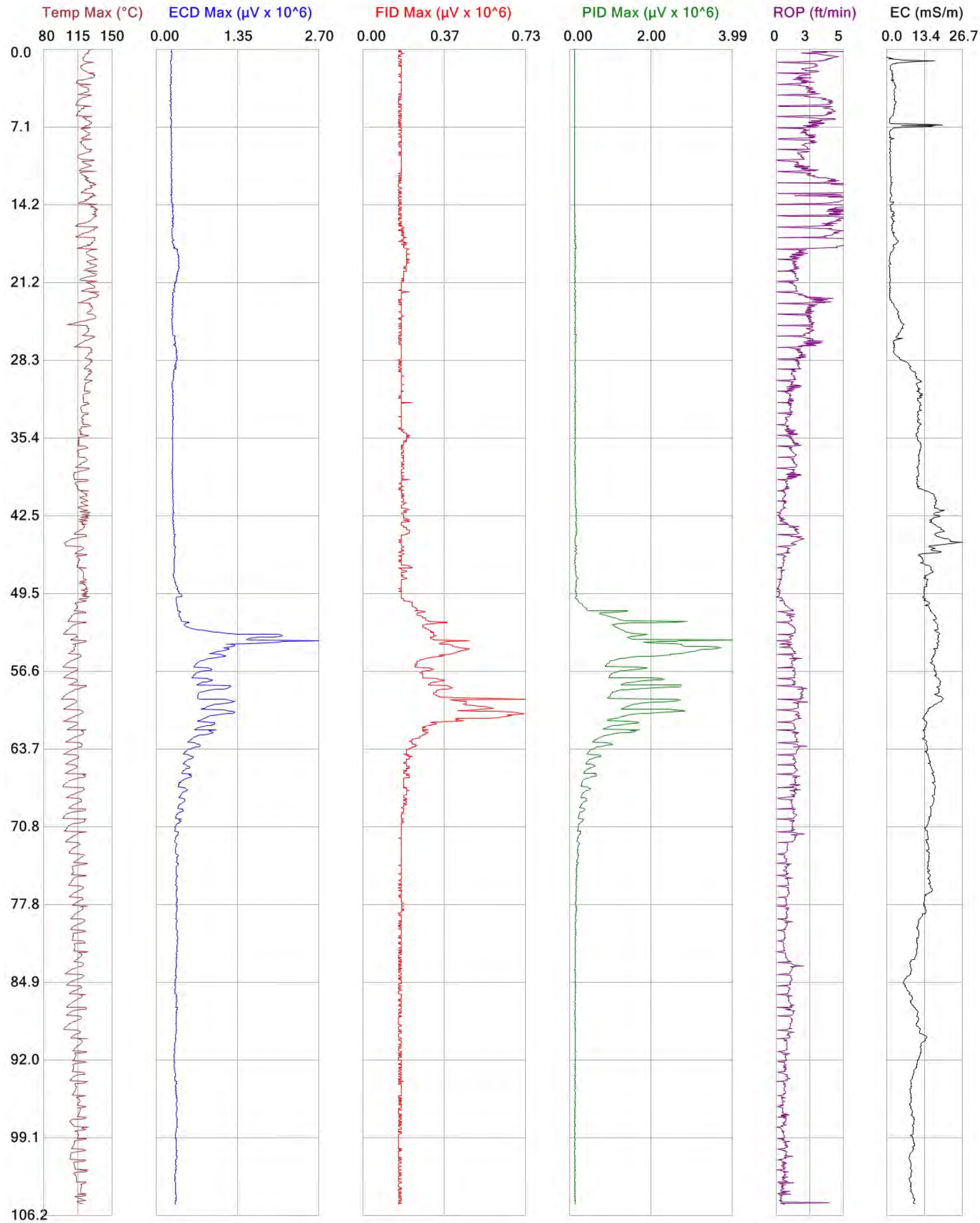

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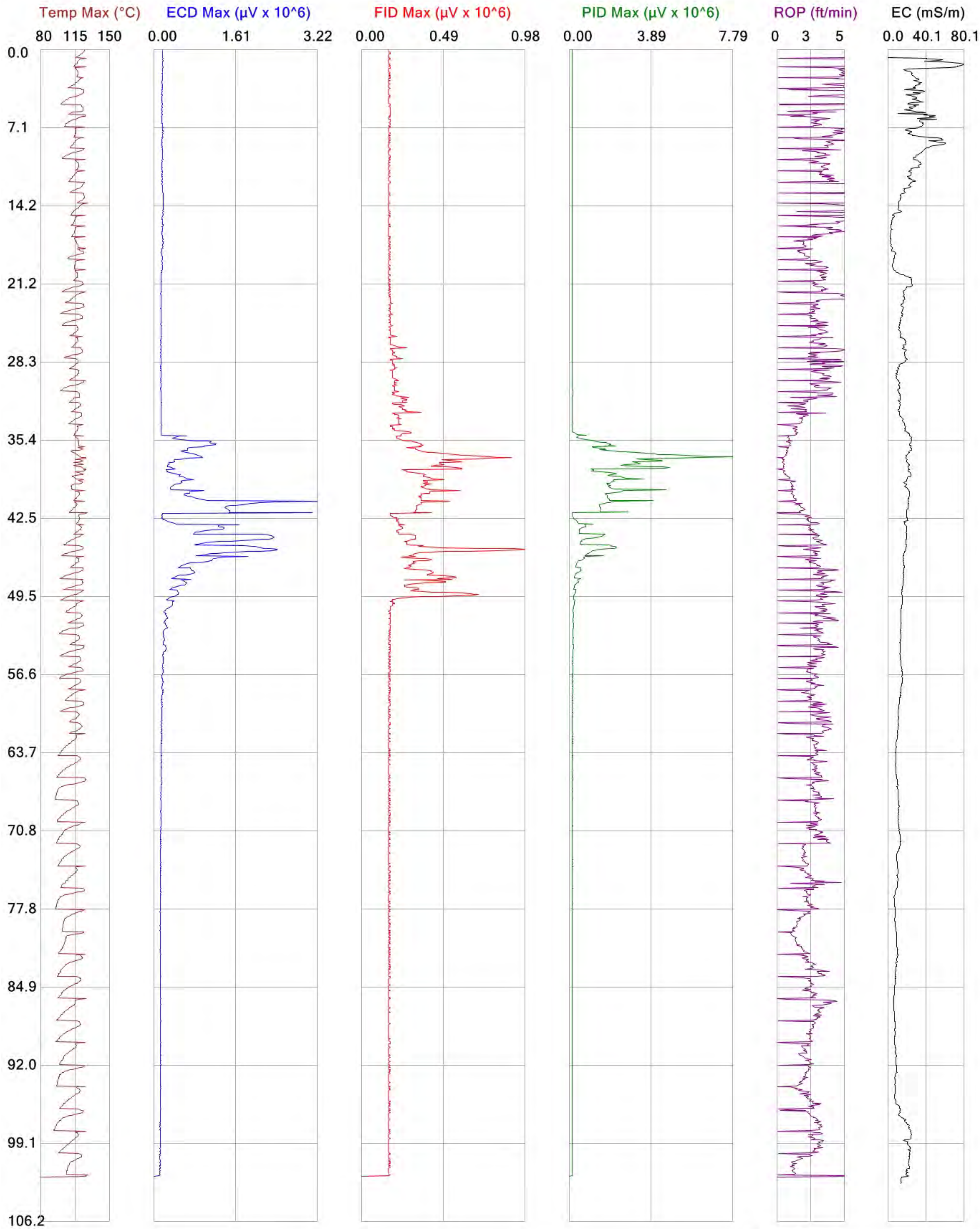
Project ID: Bofers Nobel	Location:

COLUMBIA TECHNOLOGIES



COLUMBIA TECHNOLOGIES

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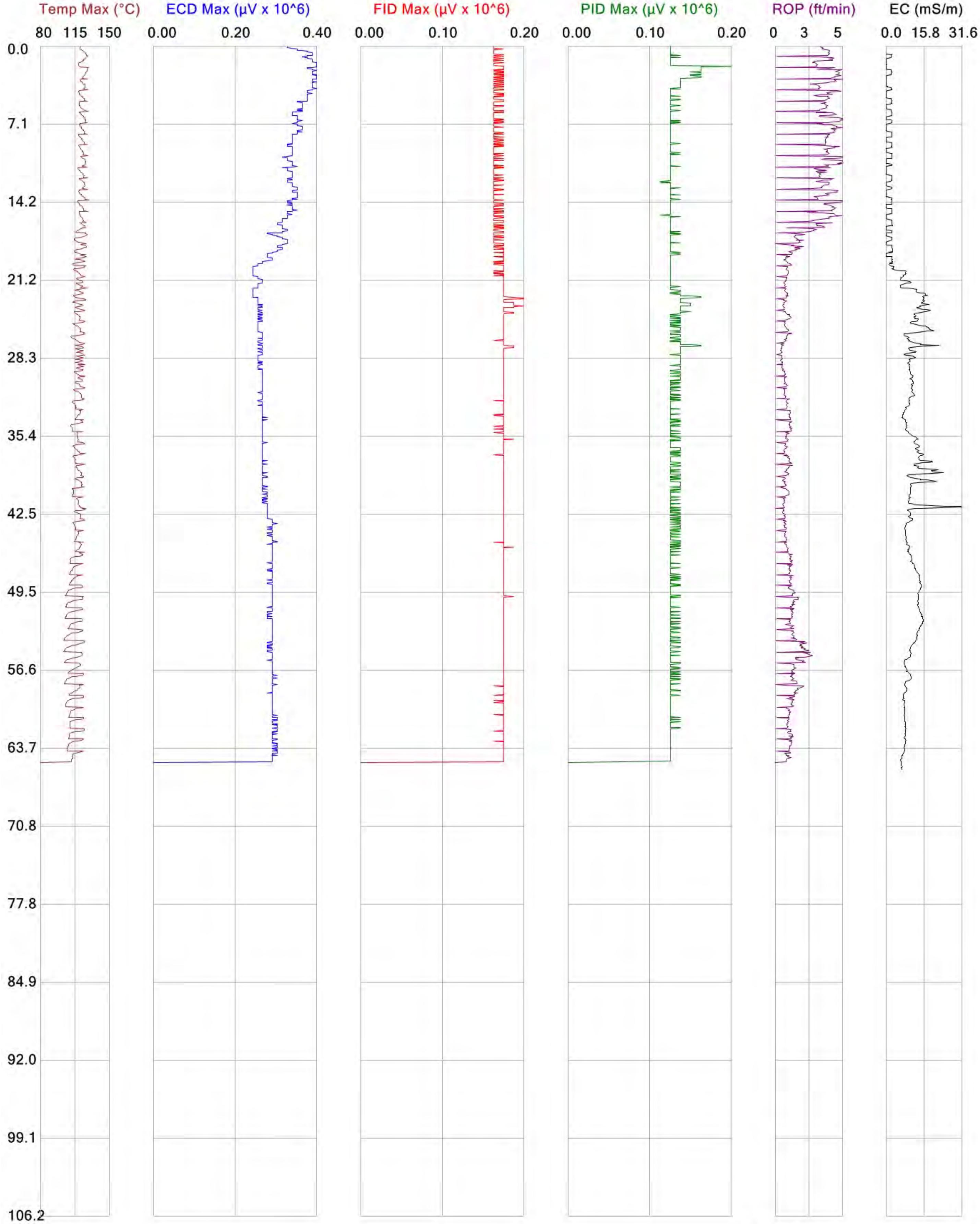

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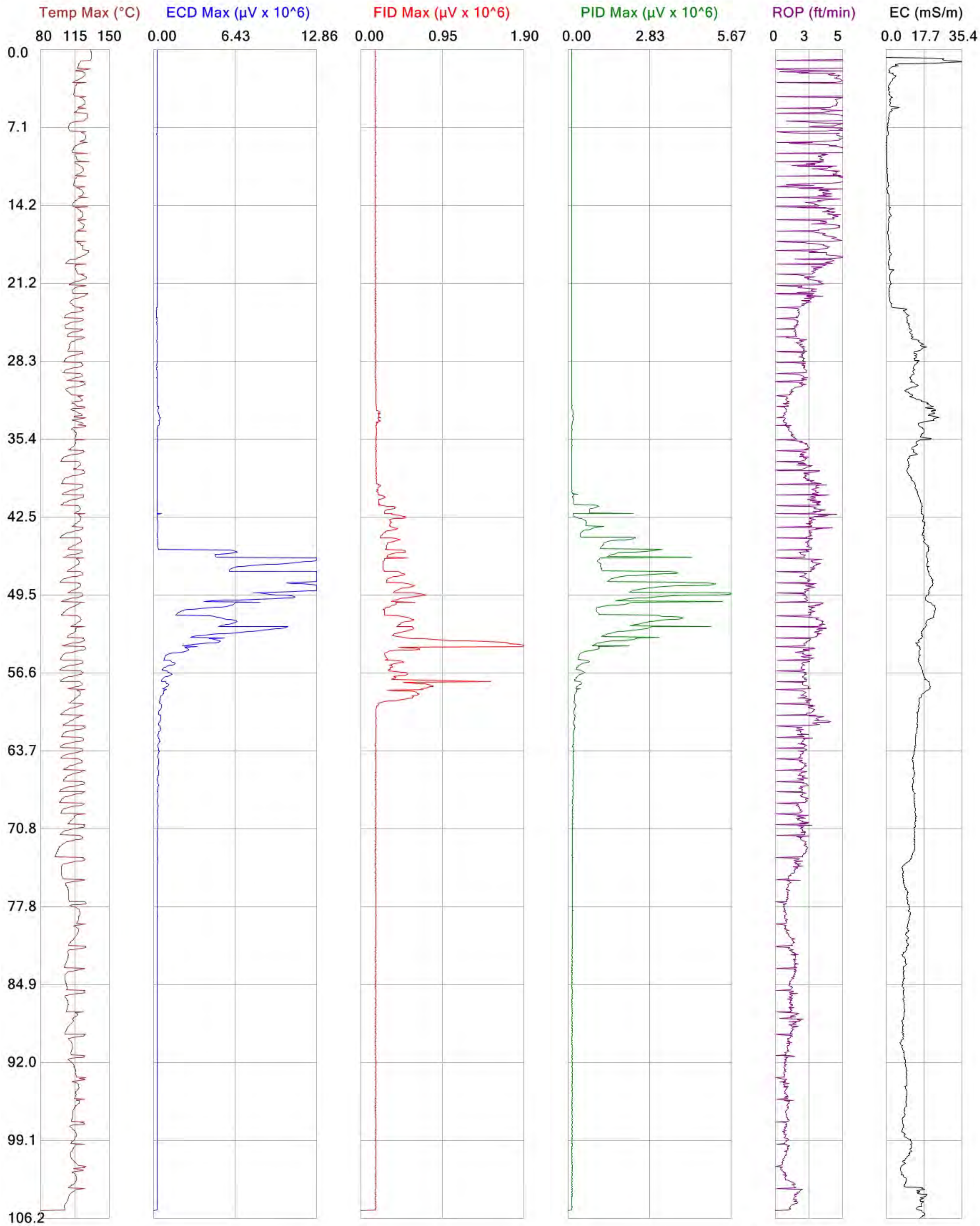

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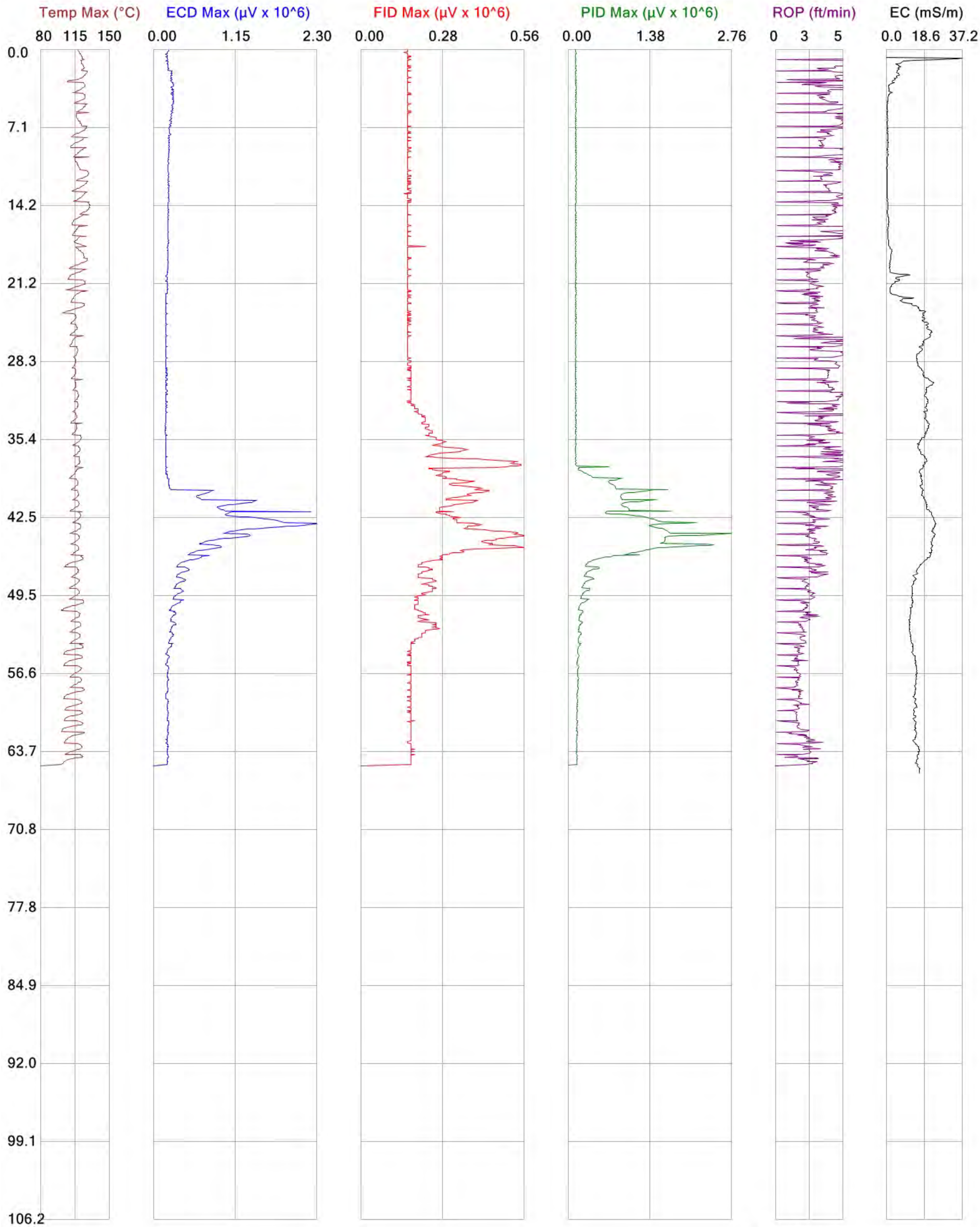
COLUMBIA TECHNOLOGIES



COLUMBIA TECHNOLOGIES

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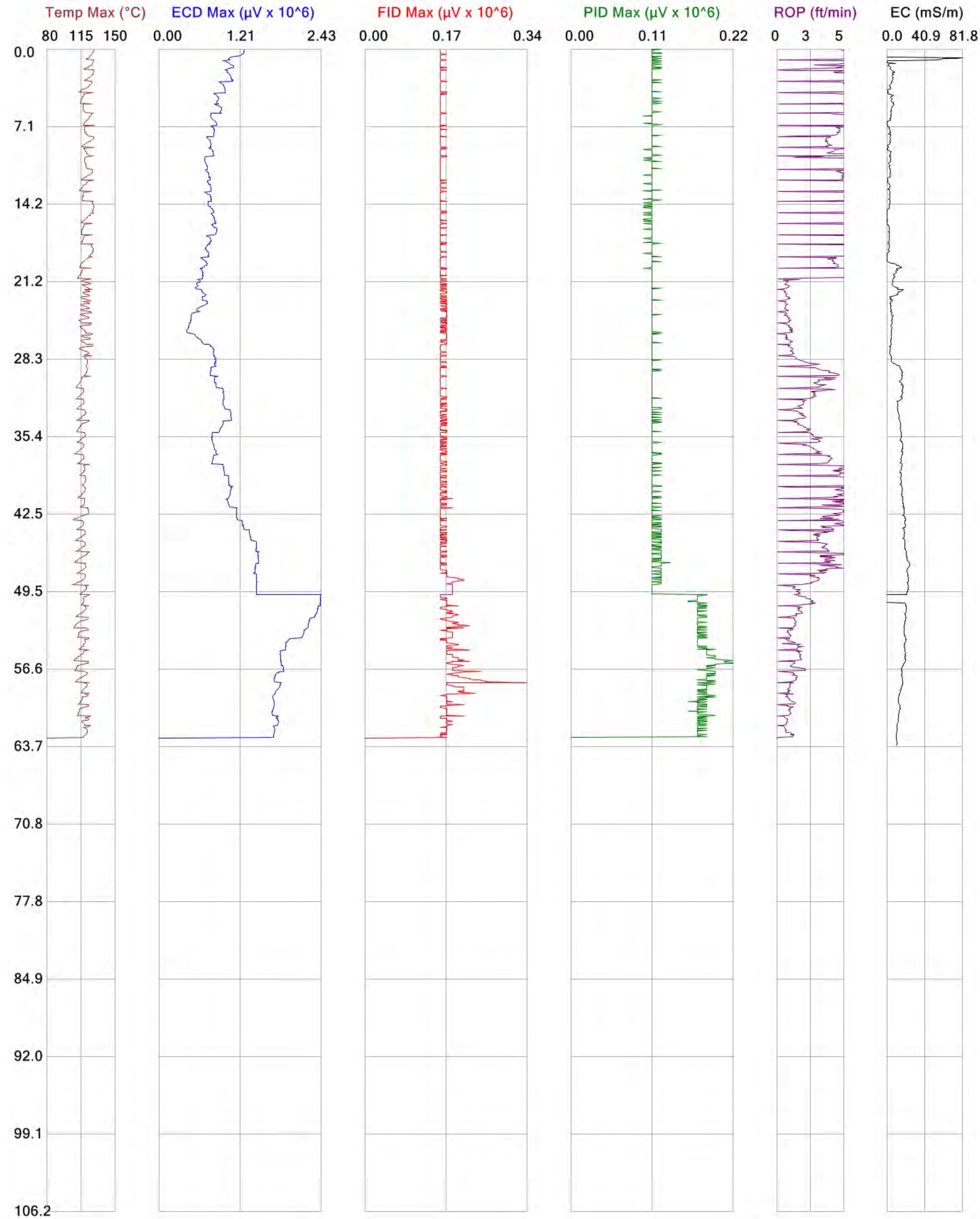

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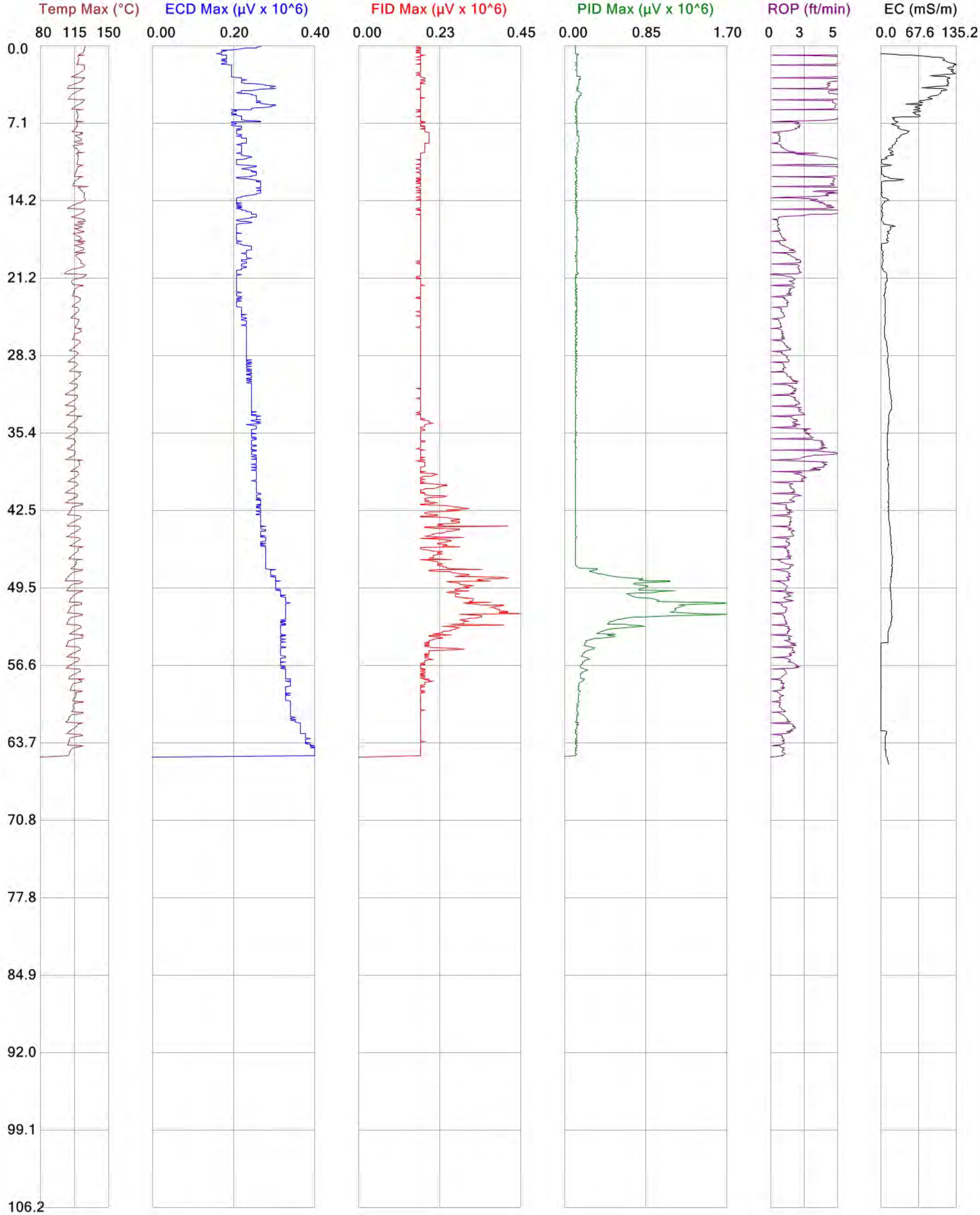

COLUMBIA TECHNOLOGIES

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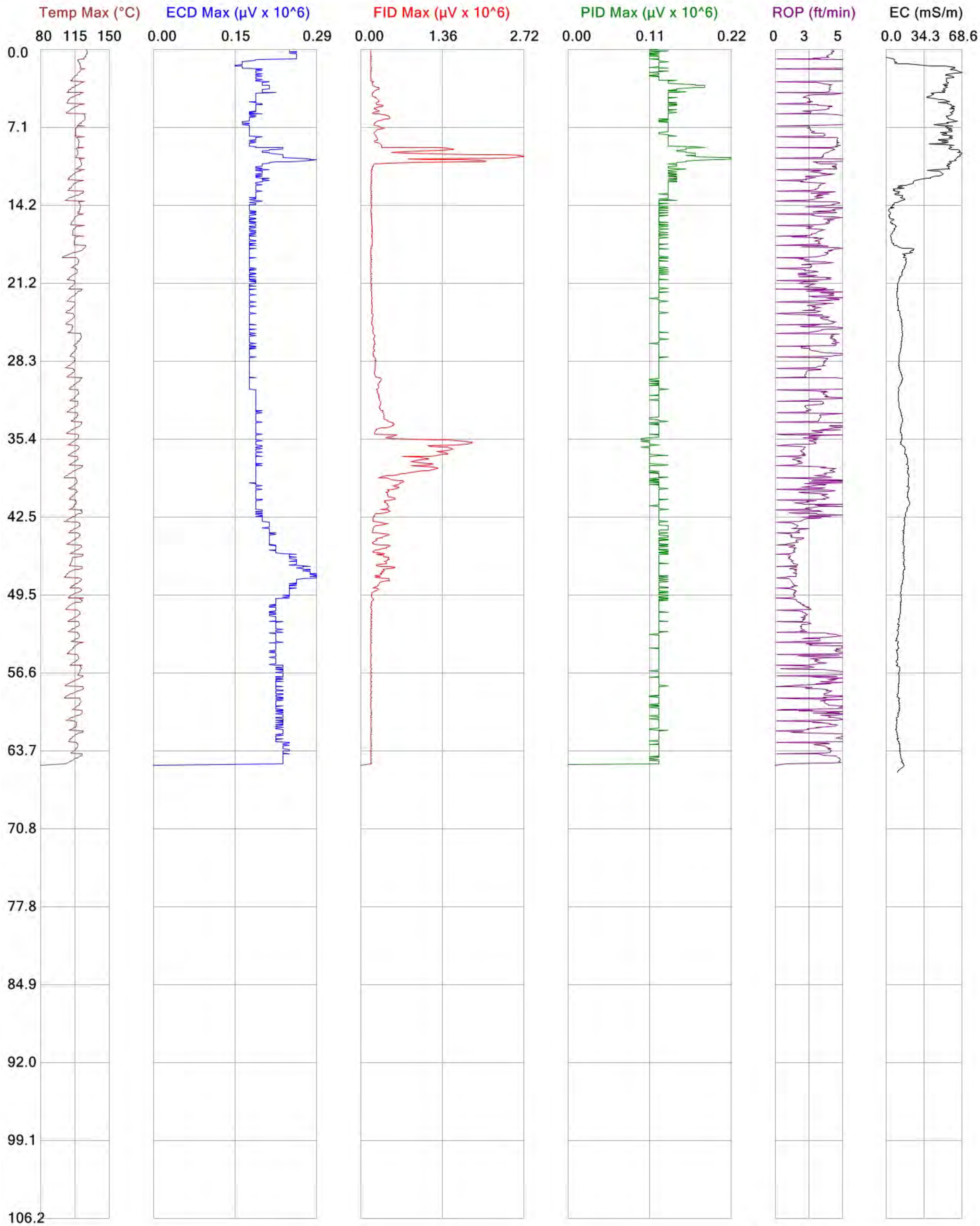

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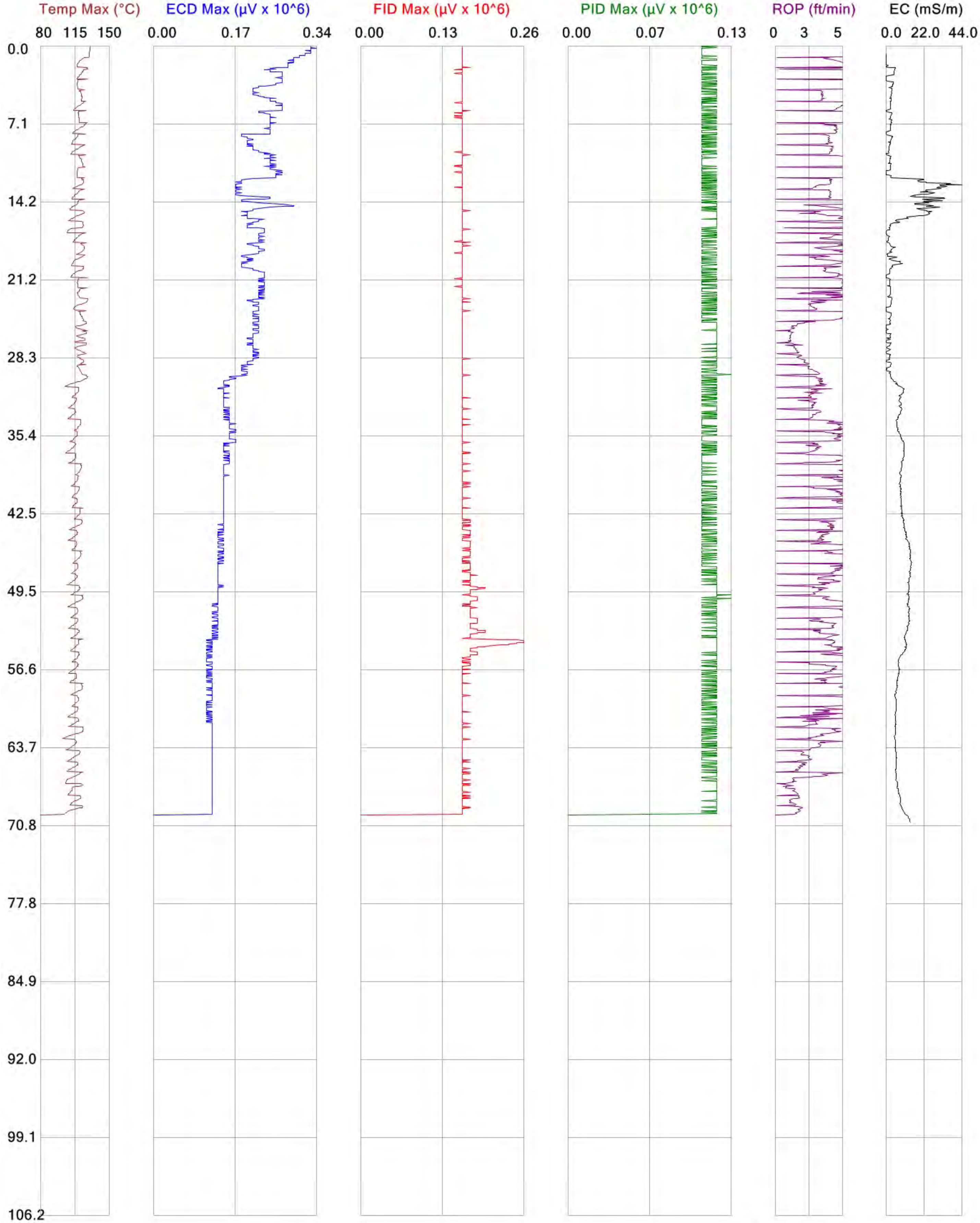

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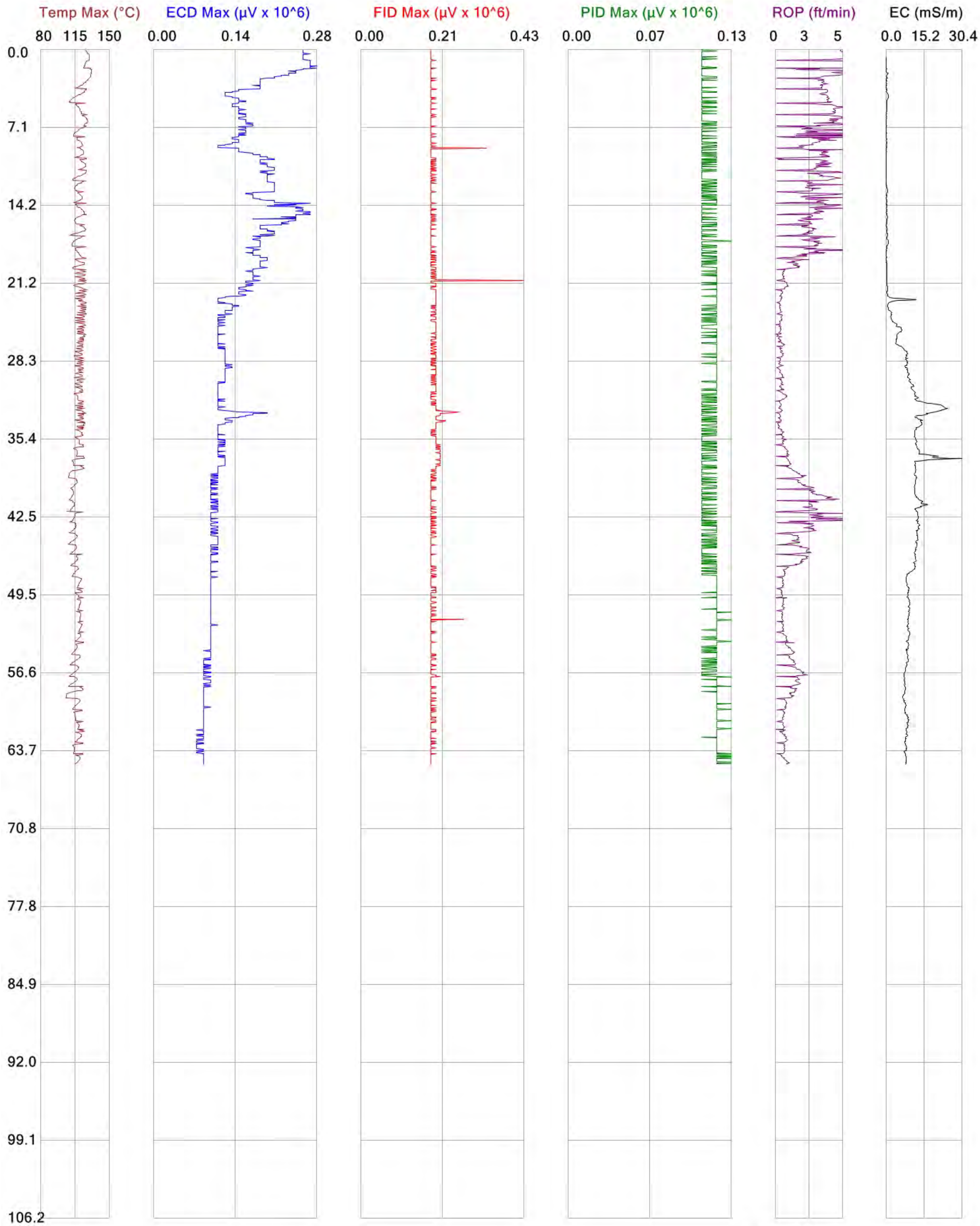

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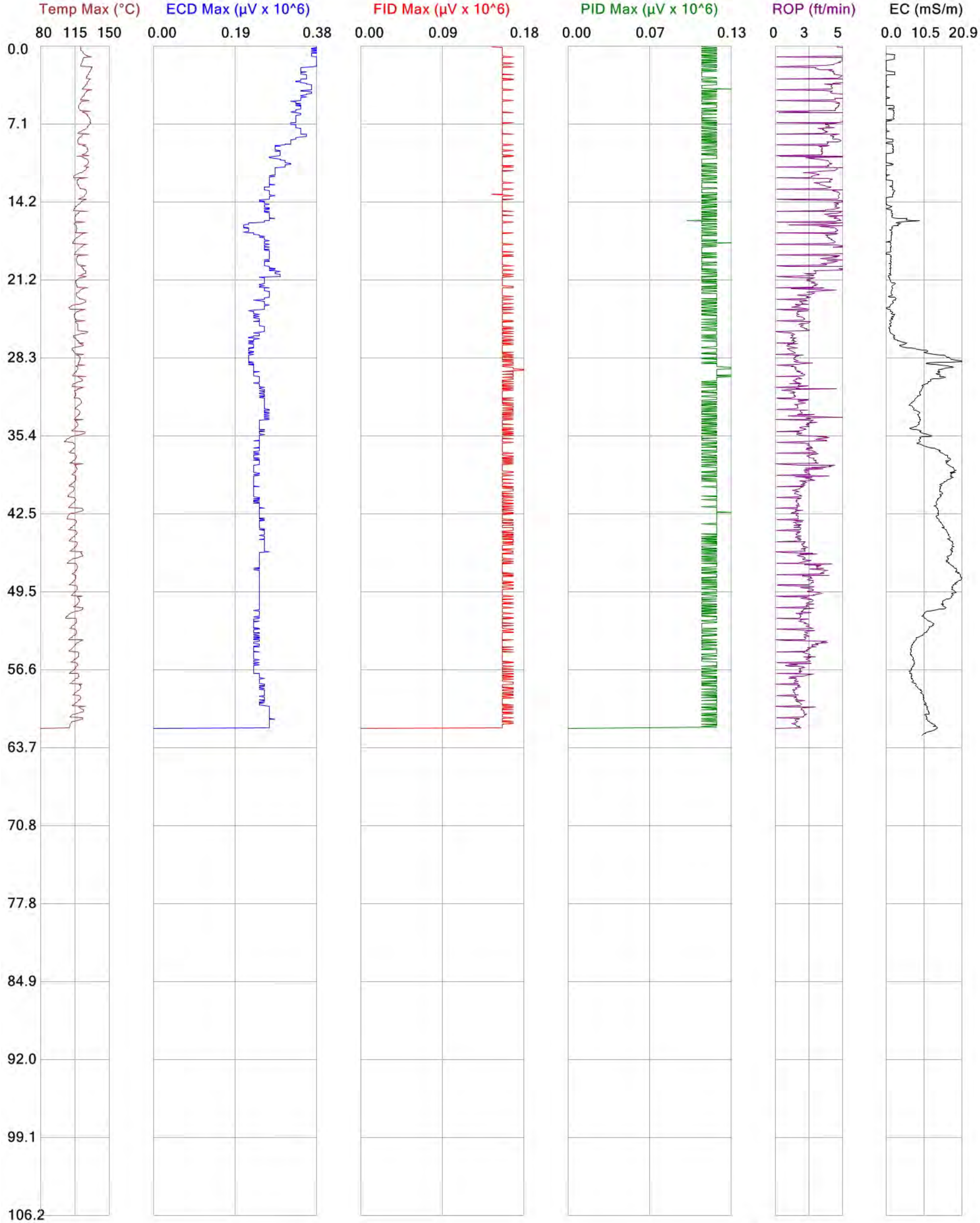
COLUMBIA TECHNOLOGIES



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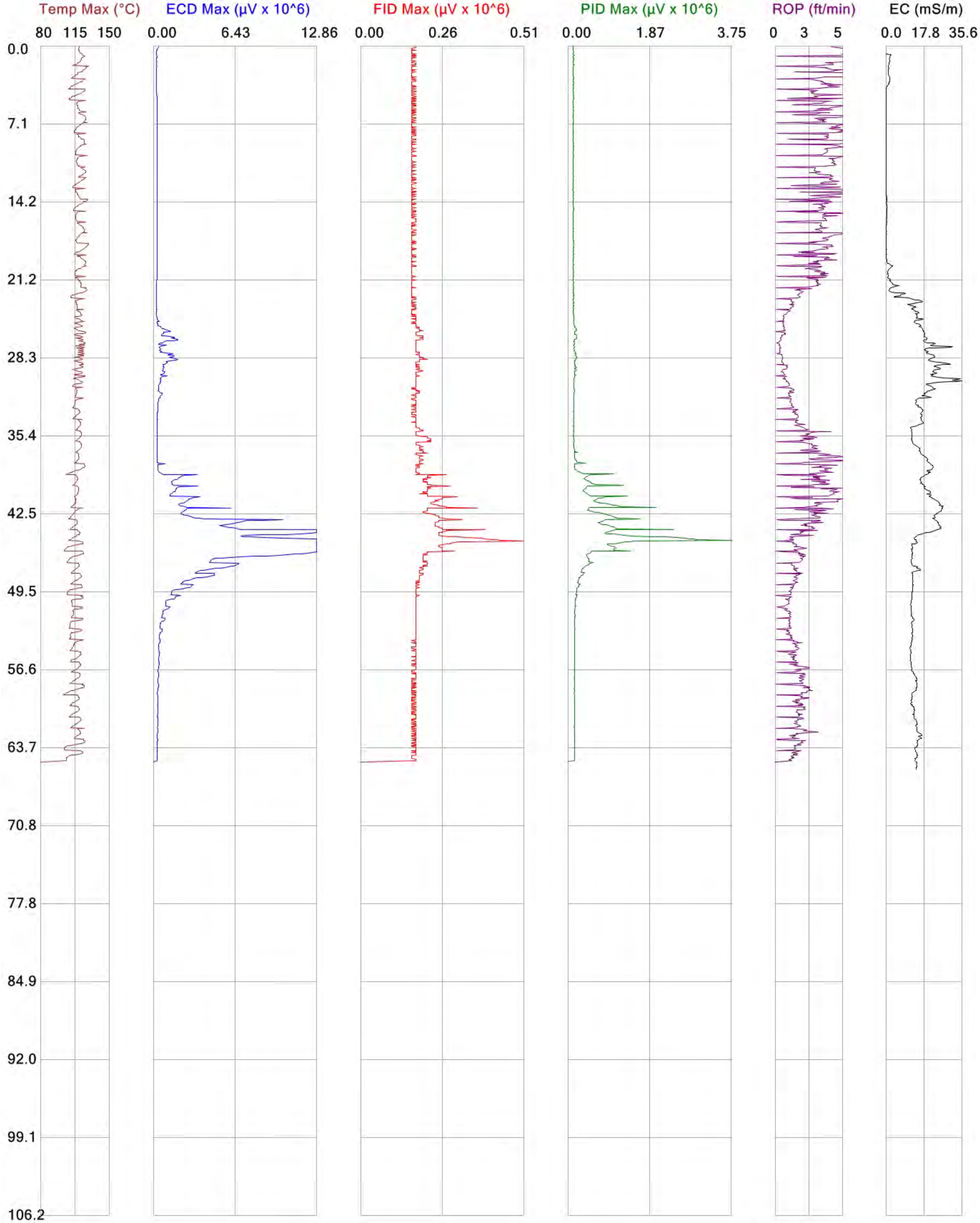

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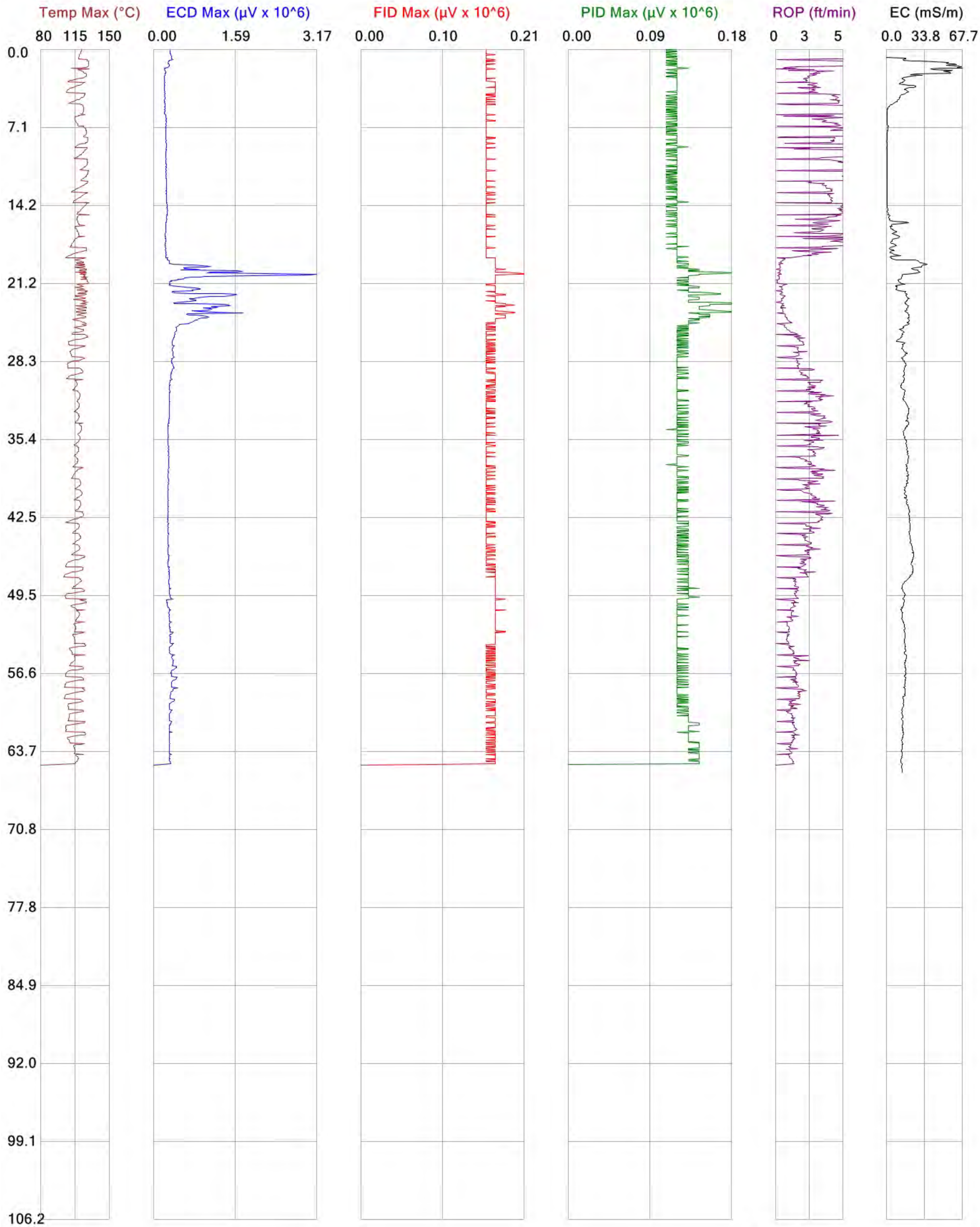

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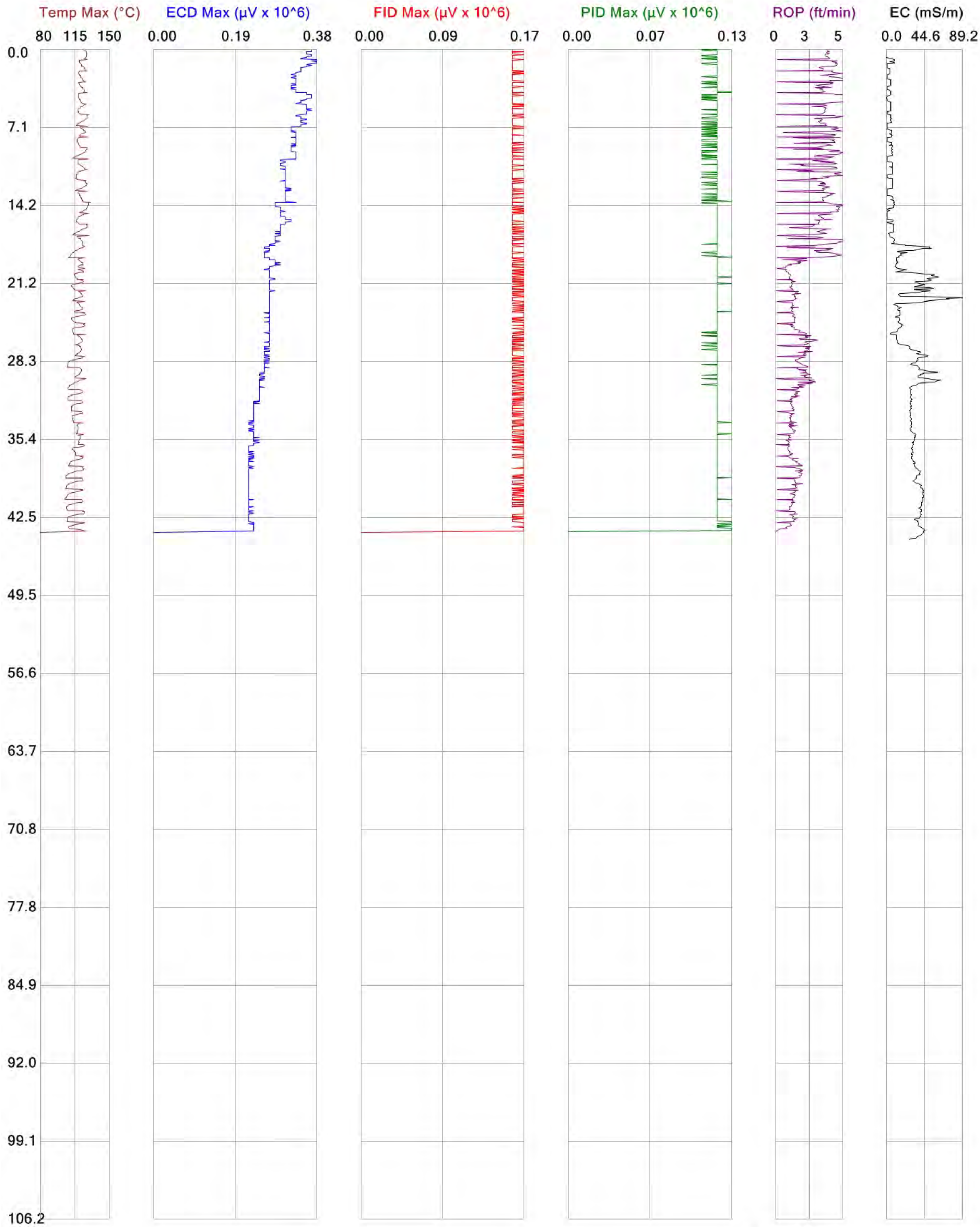

COLUMBIA TECHNOLOGIES

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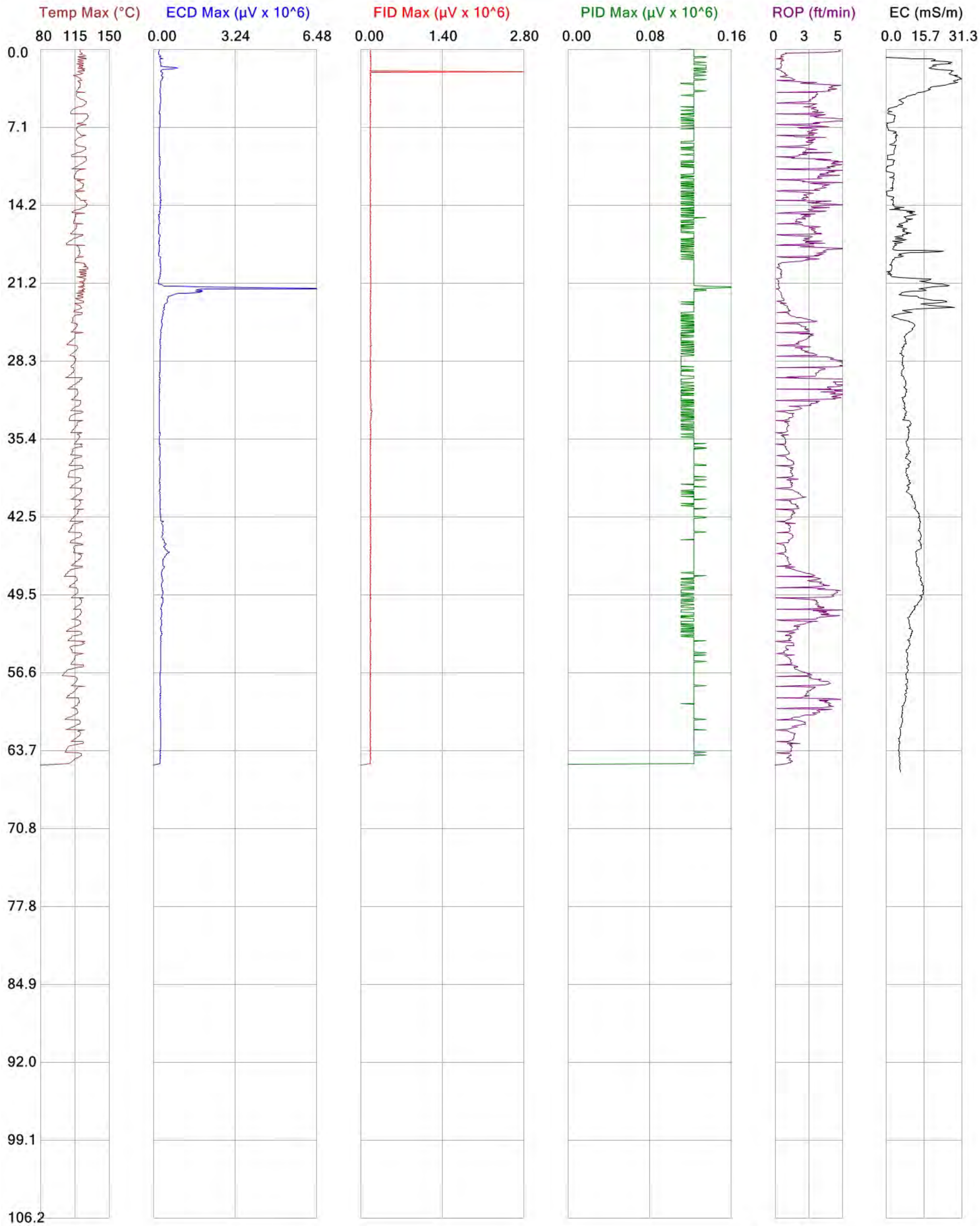

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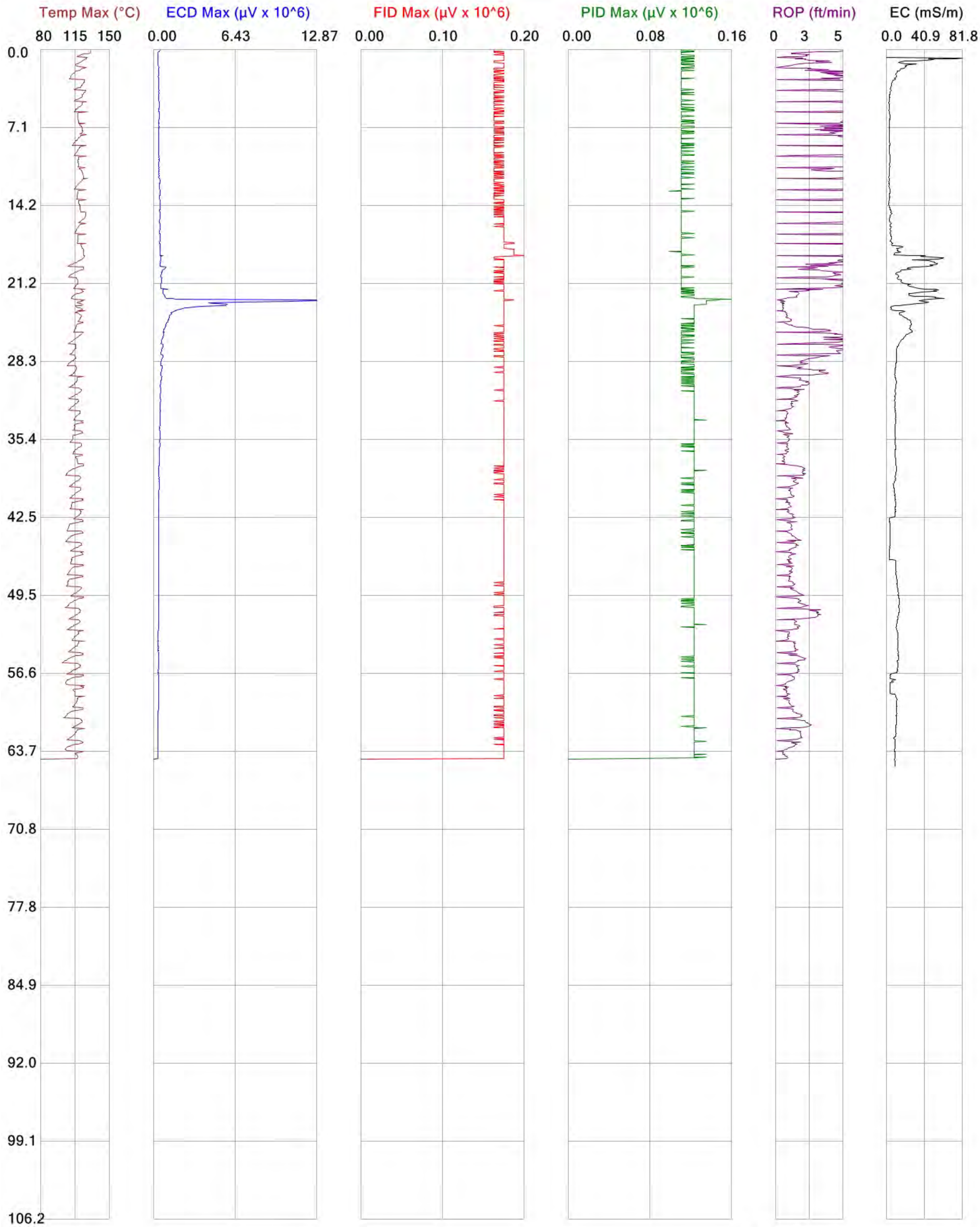

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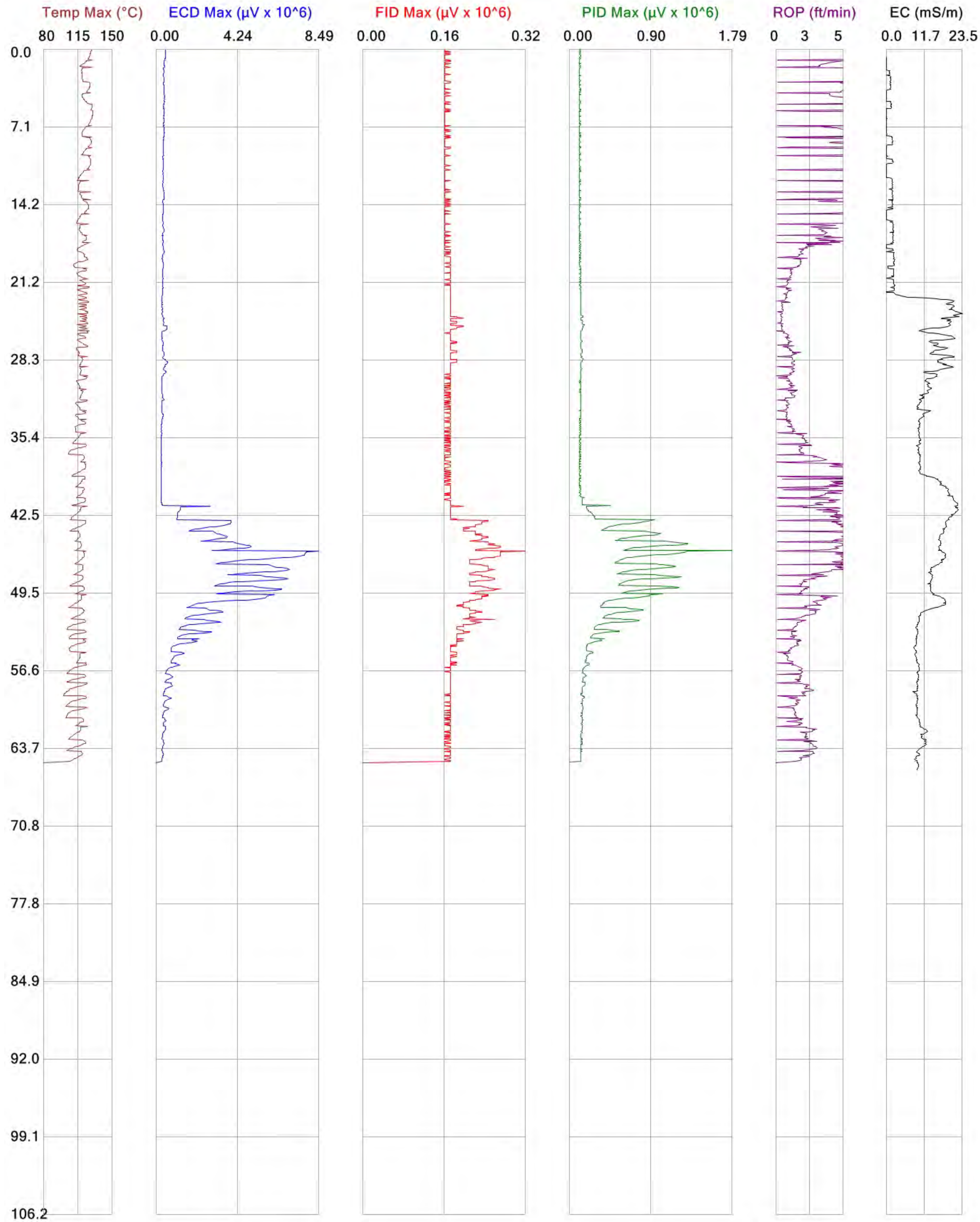

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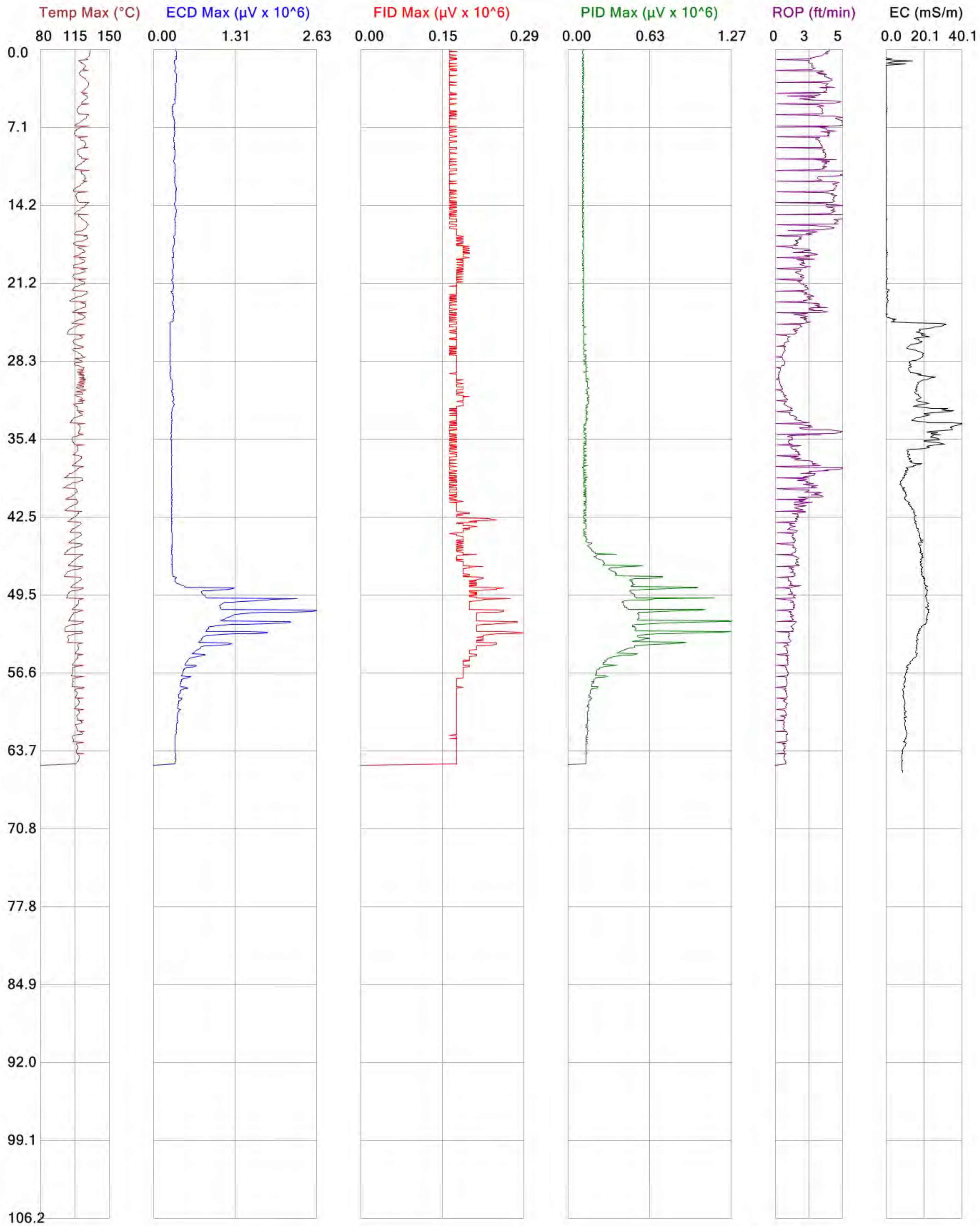

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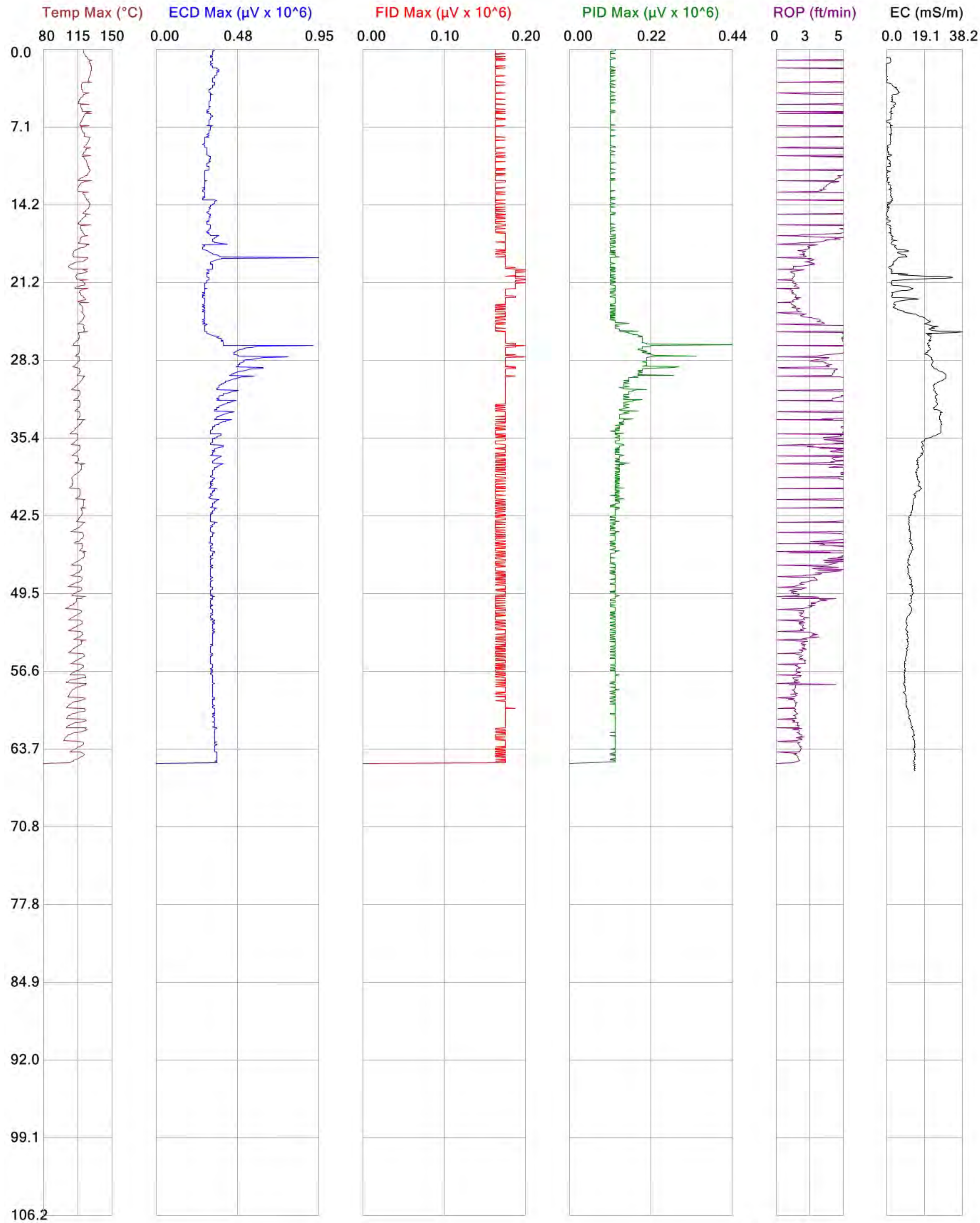

COLUMBIA TECHNOLOGIES

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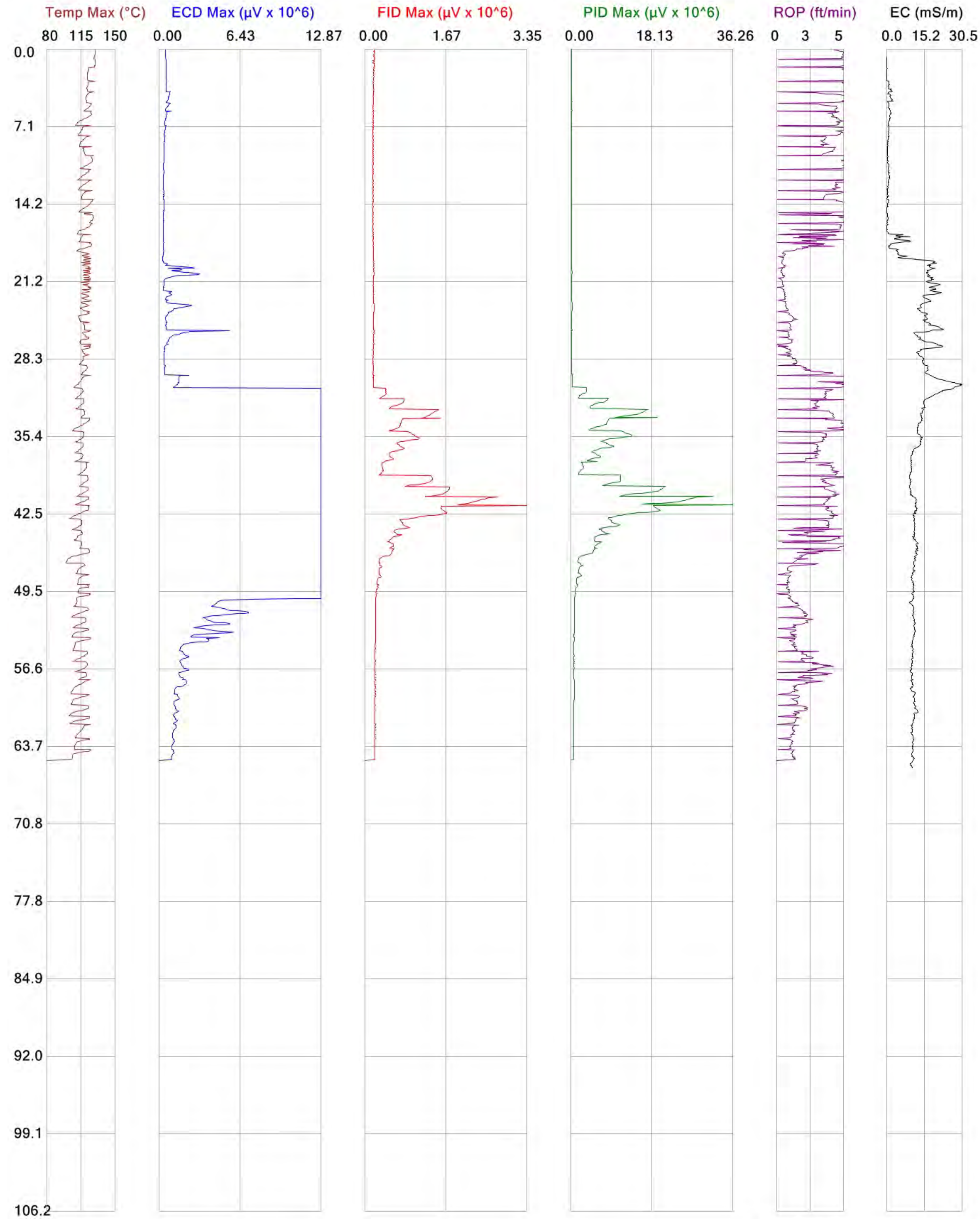

COLUMBIA TECHNOLOGIES

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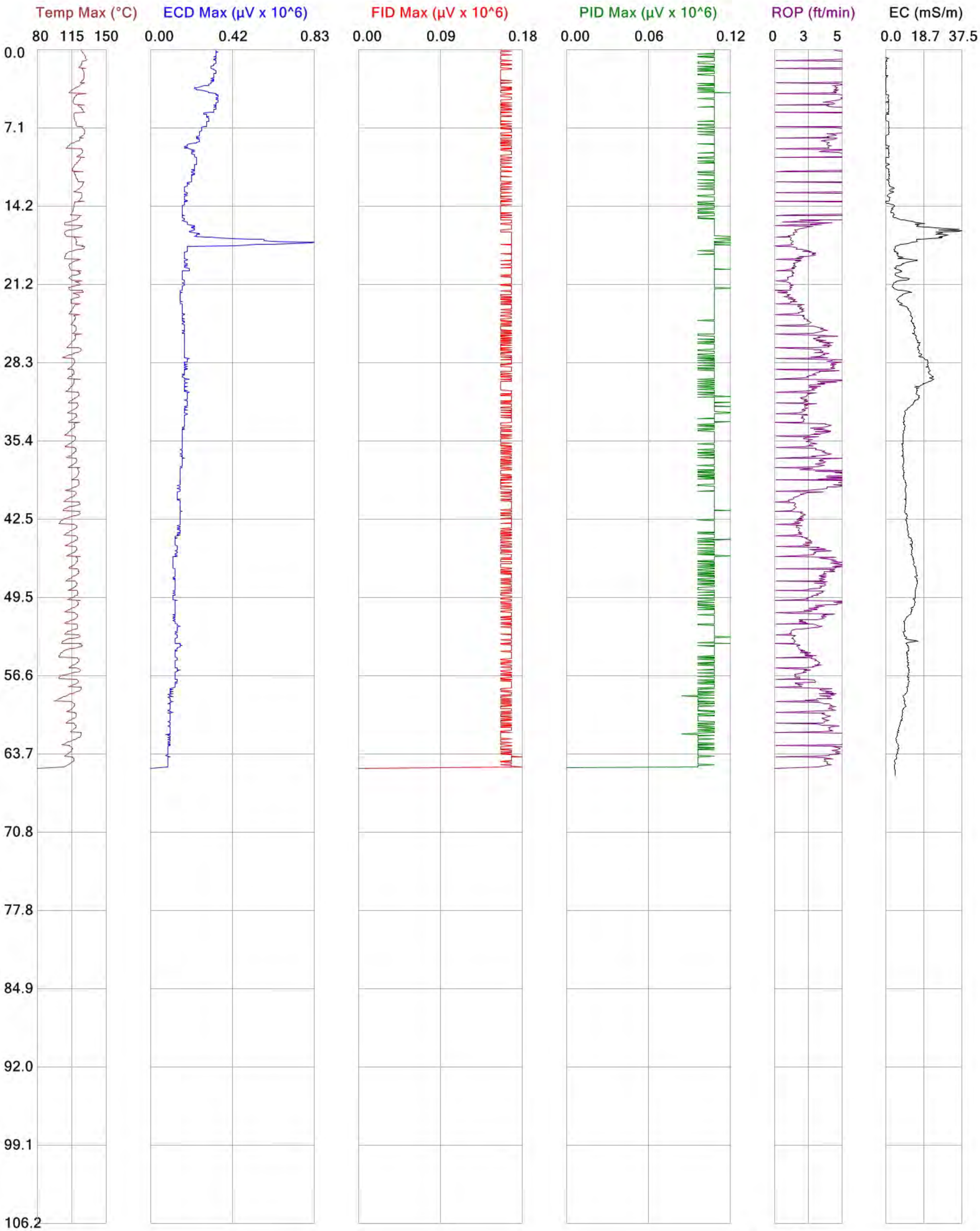

COLUMBIA TECHNOLOGIES

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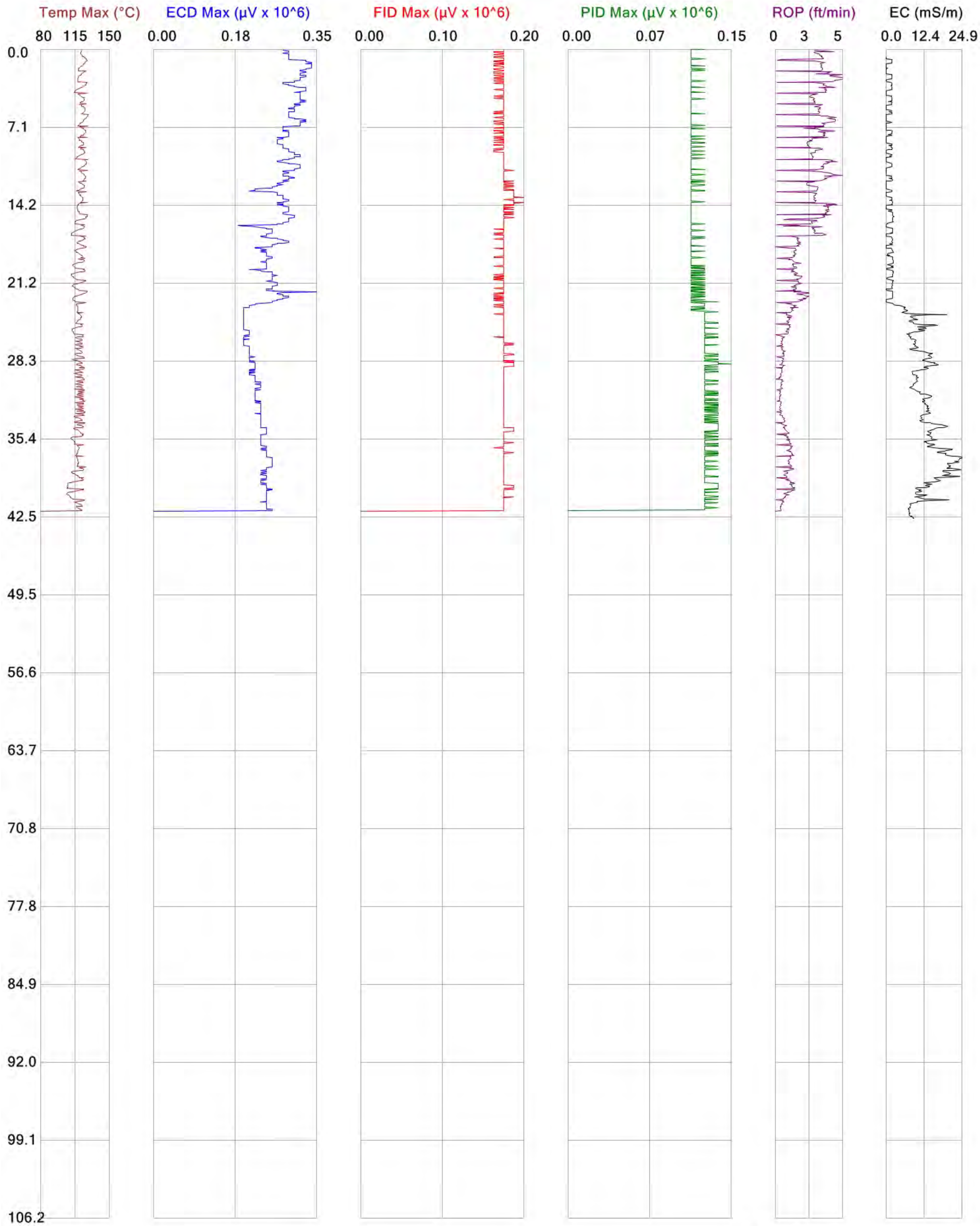

COLUMBIA TECHNOLOGIES

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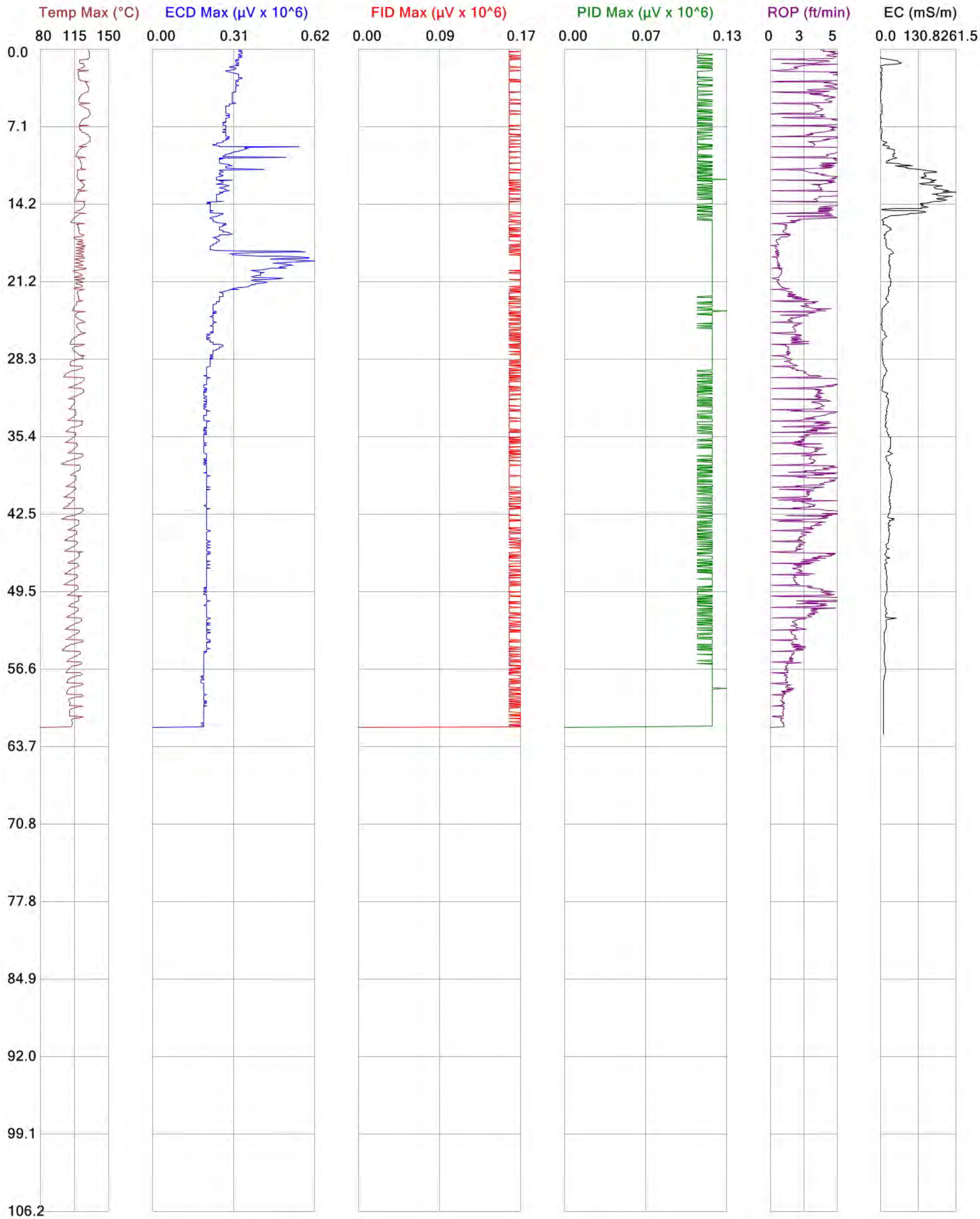

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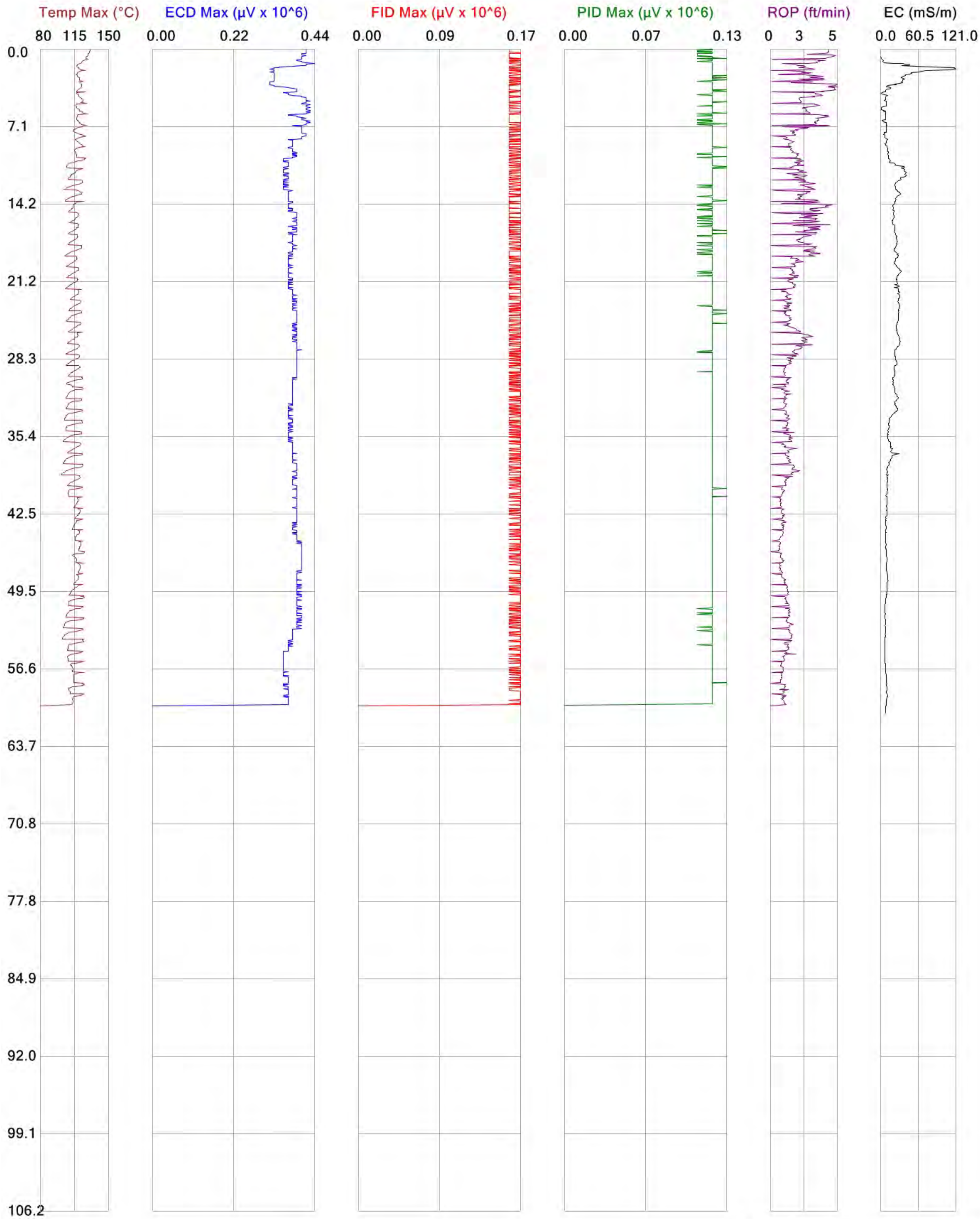

COLUMBIA TECHNOLOGIES

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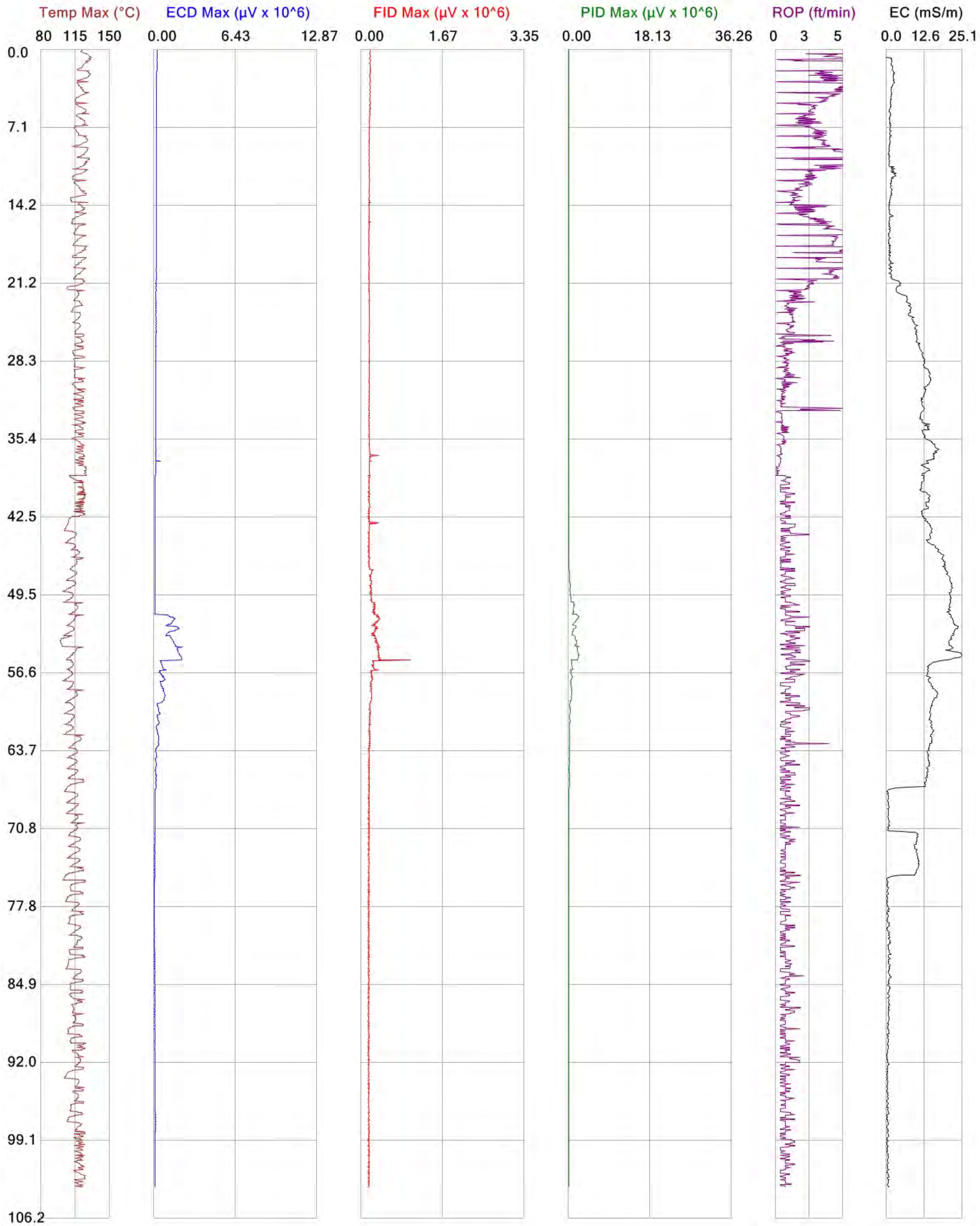
APPENDIX B

MIP Logs (Collective Scale)



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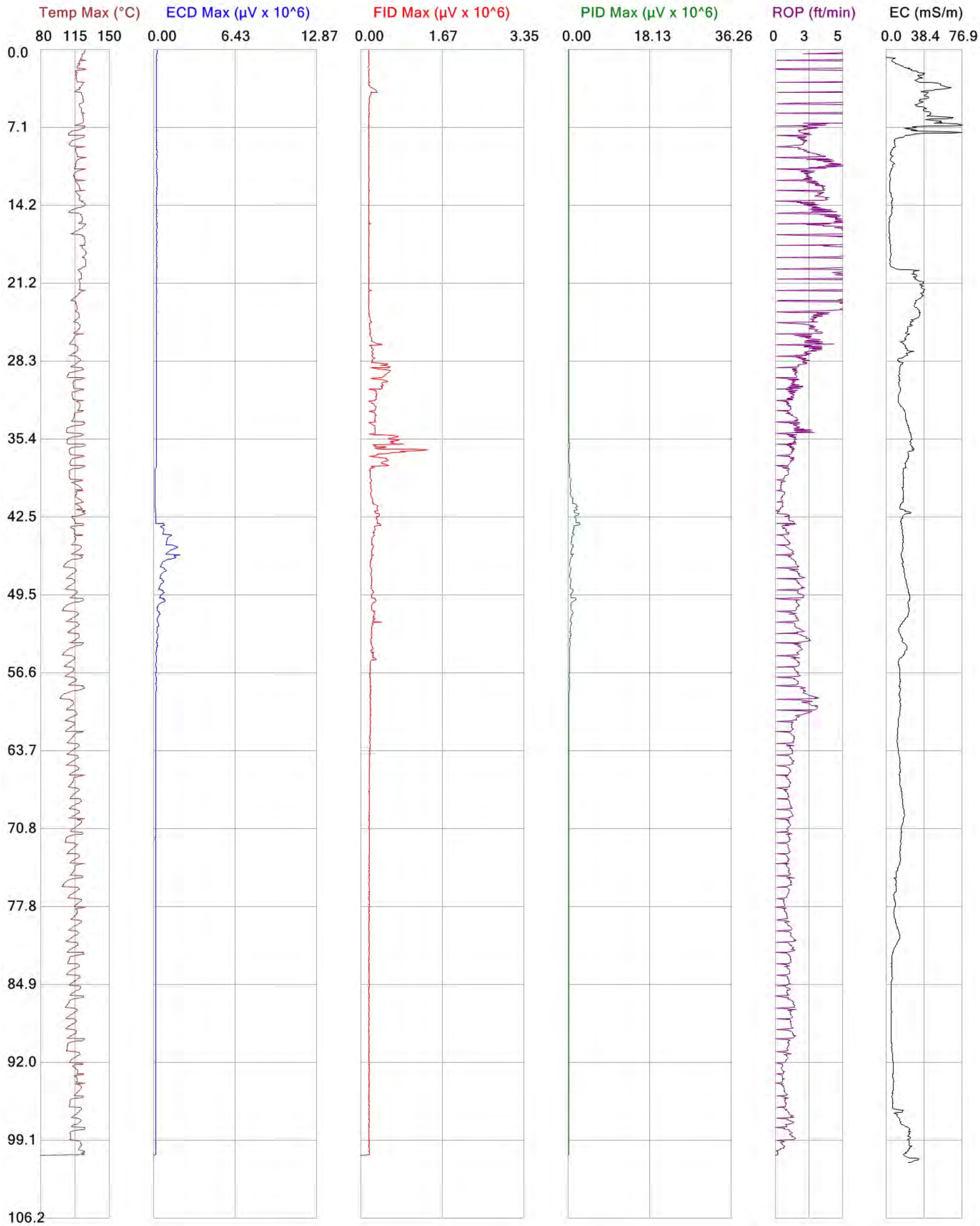

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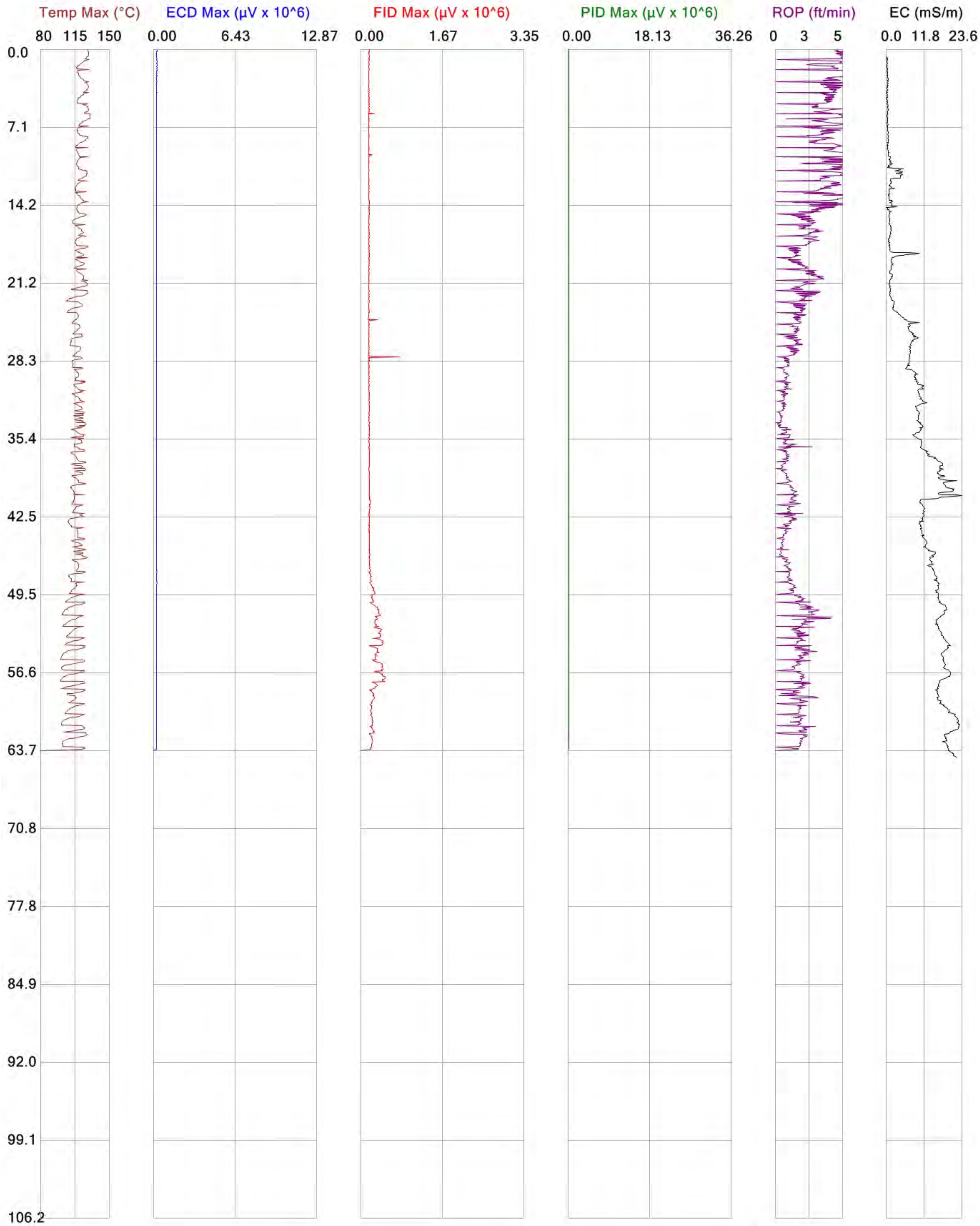

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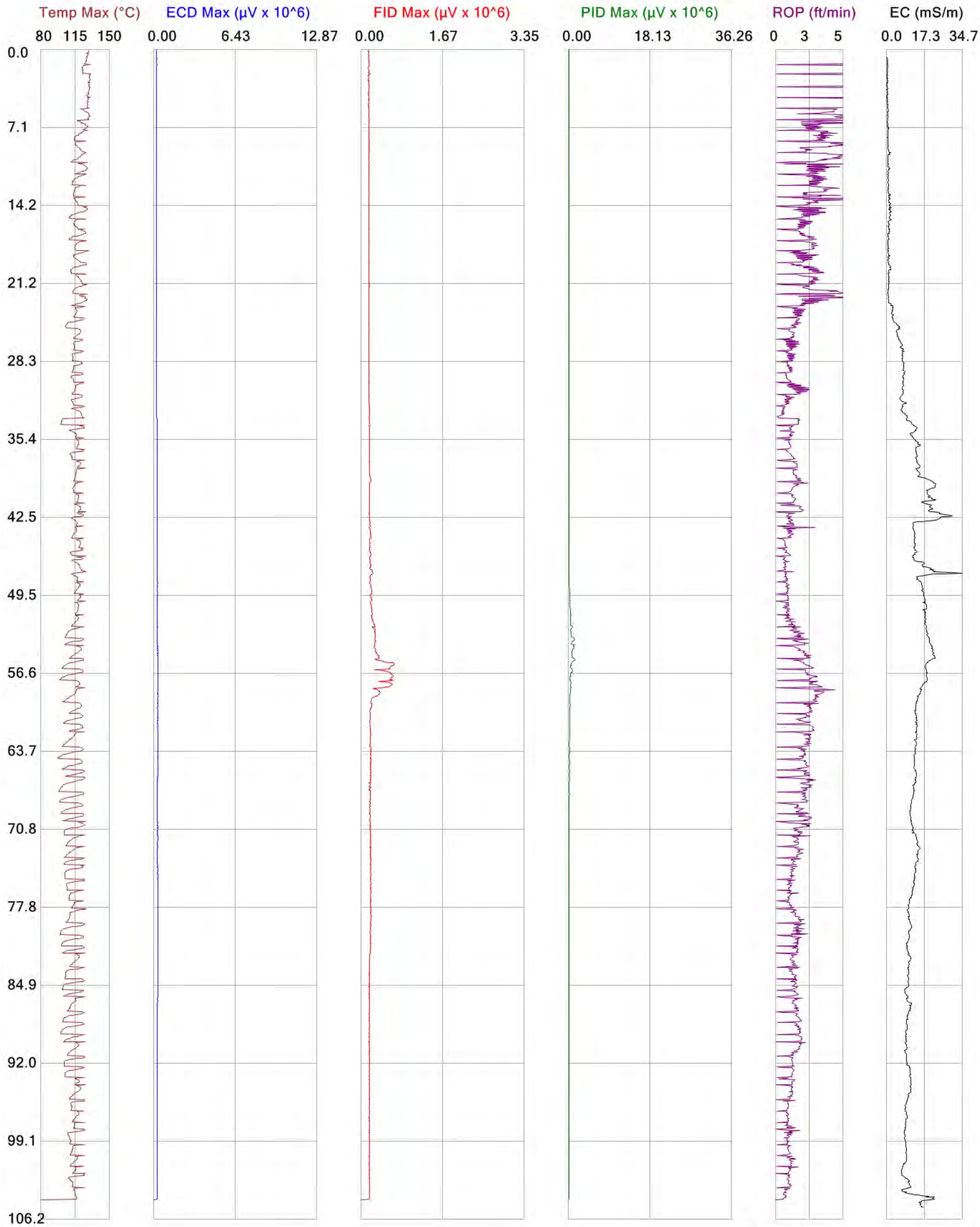

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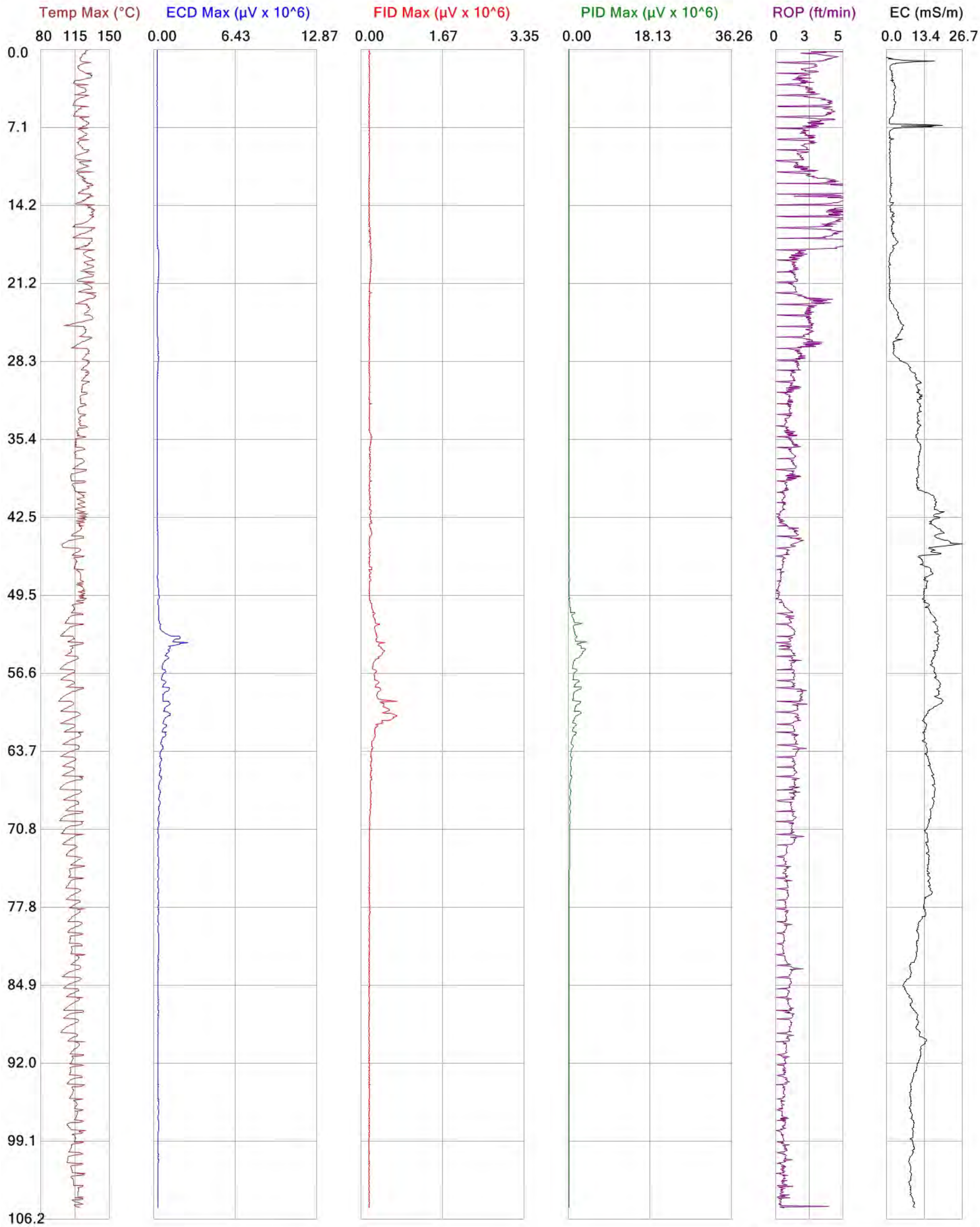
COLUMBIA TECHNOLOGIES



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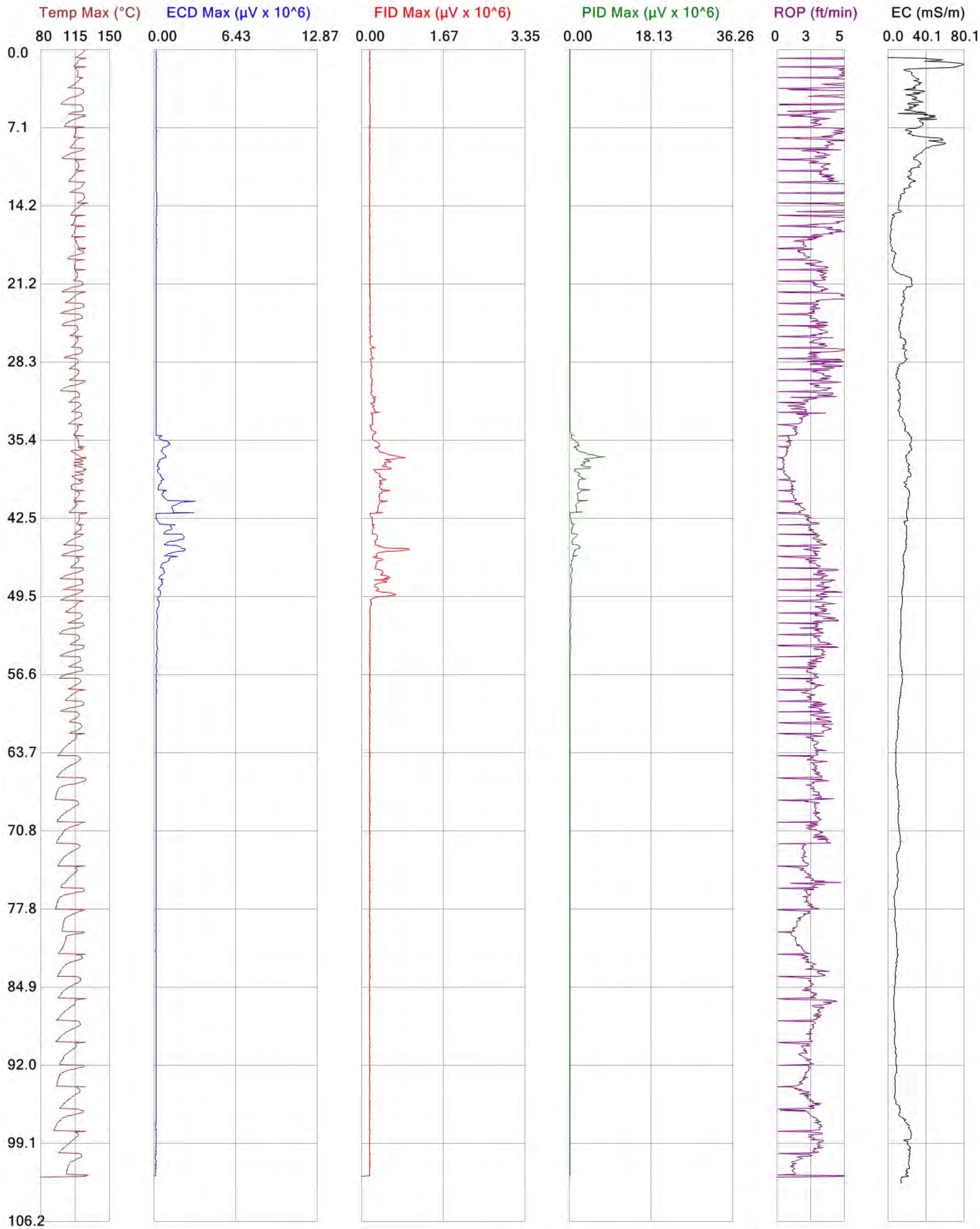

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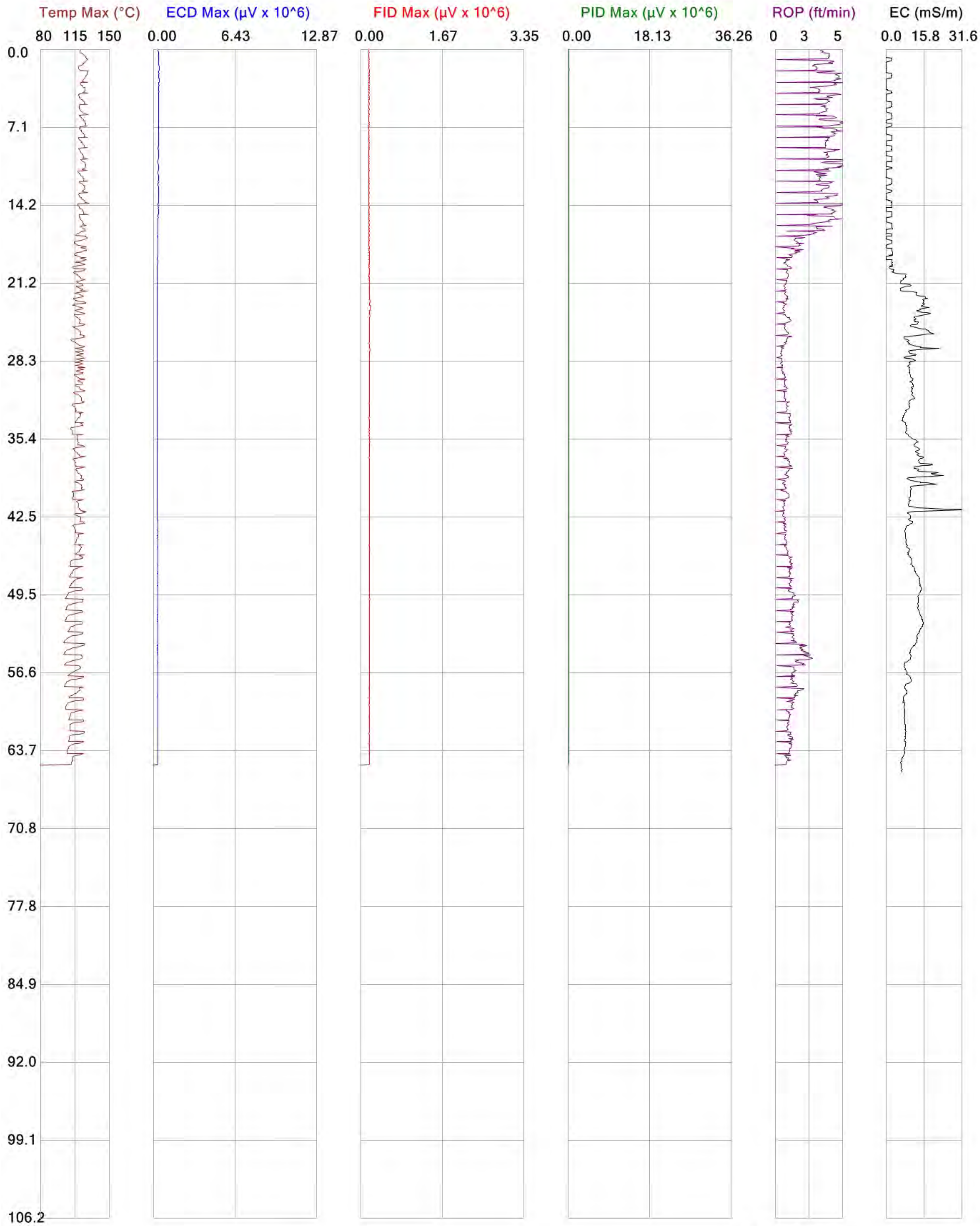

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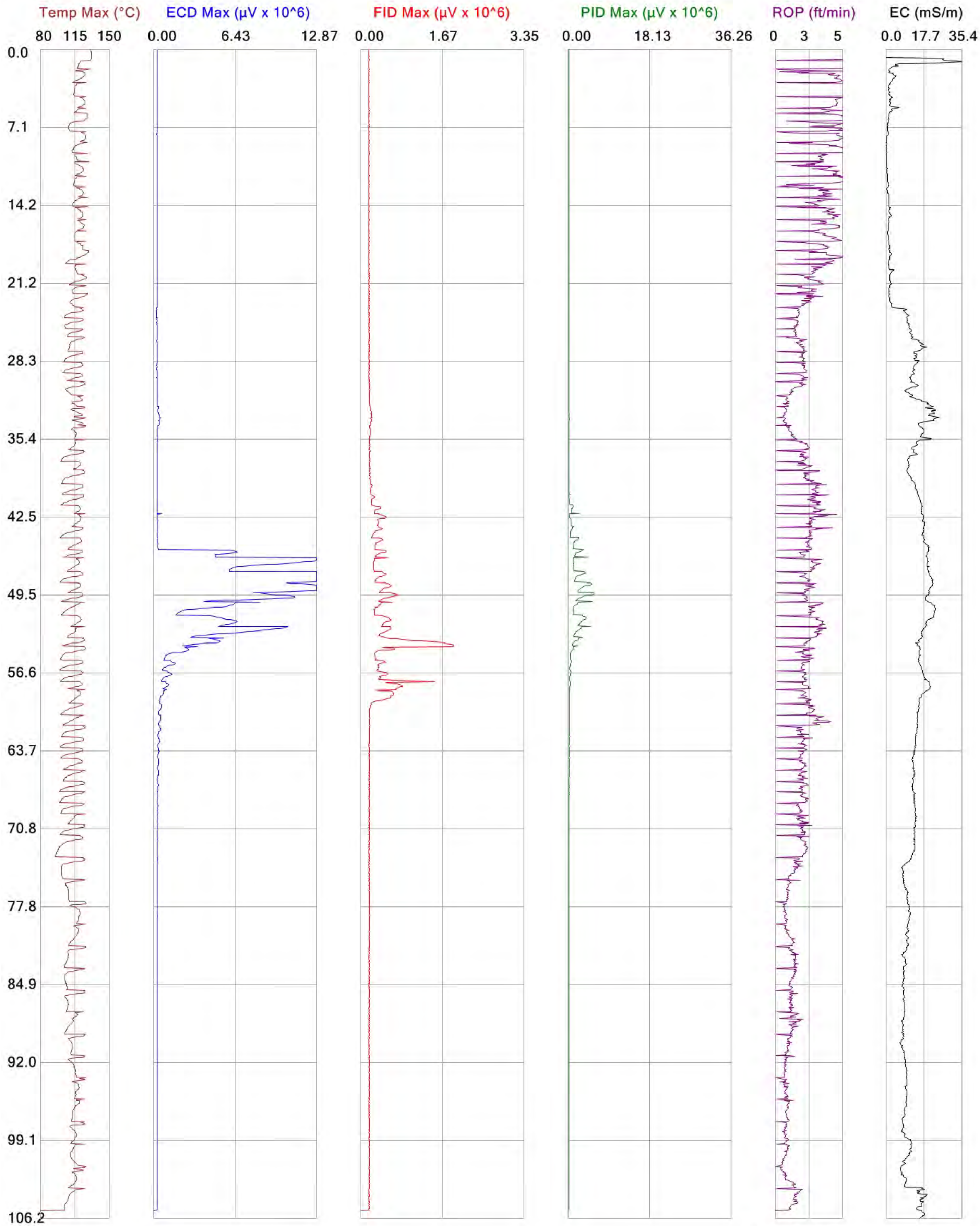

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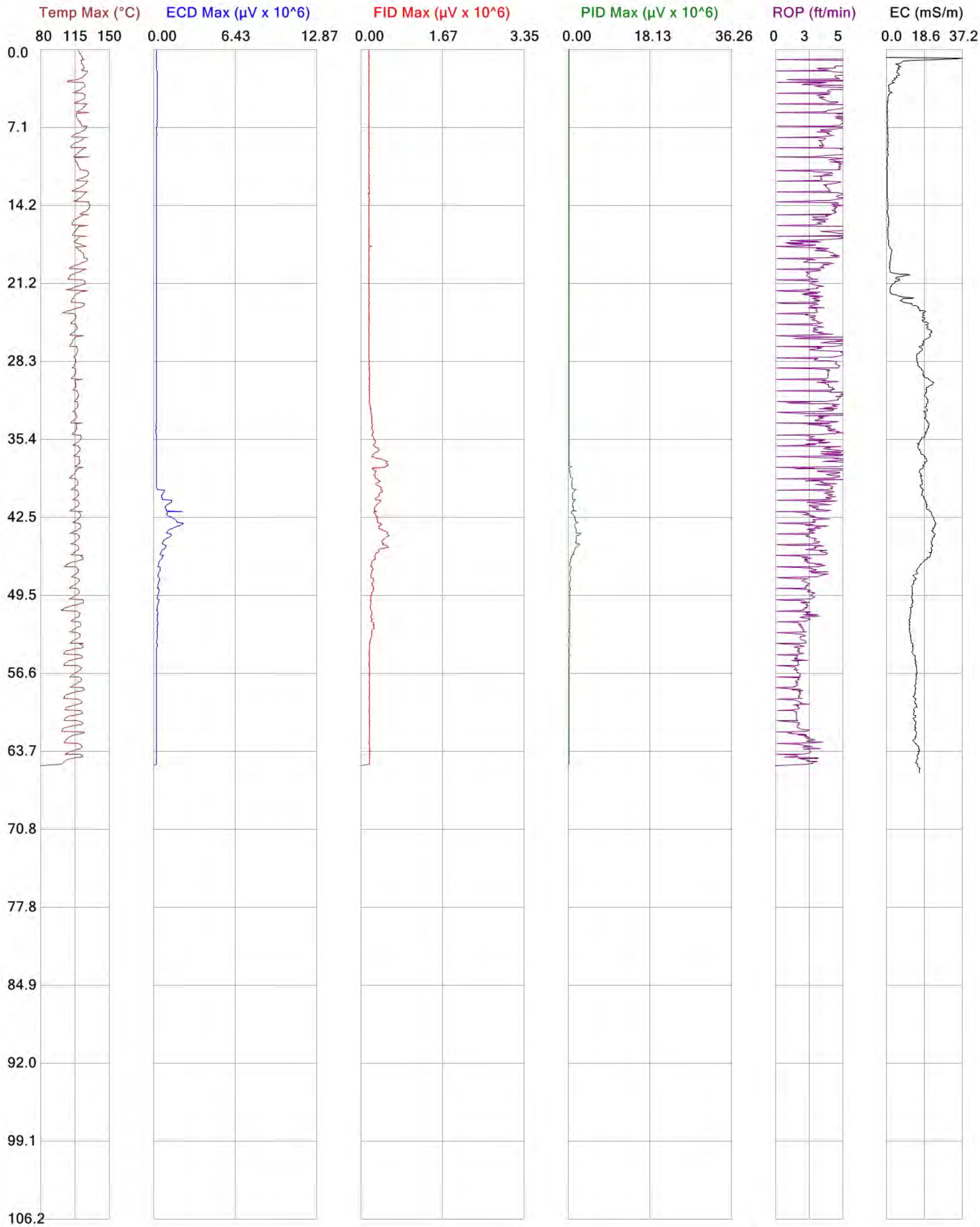

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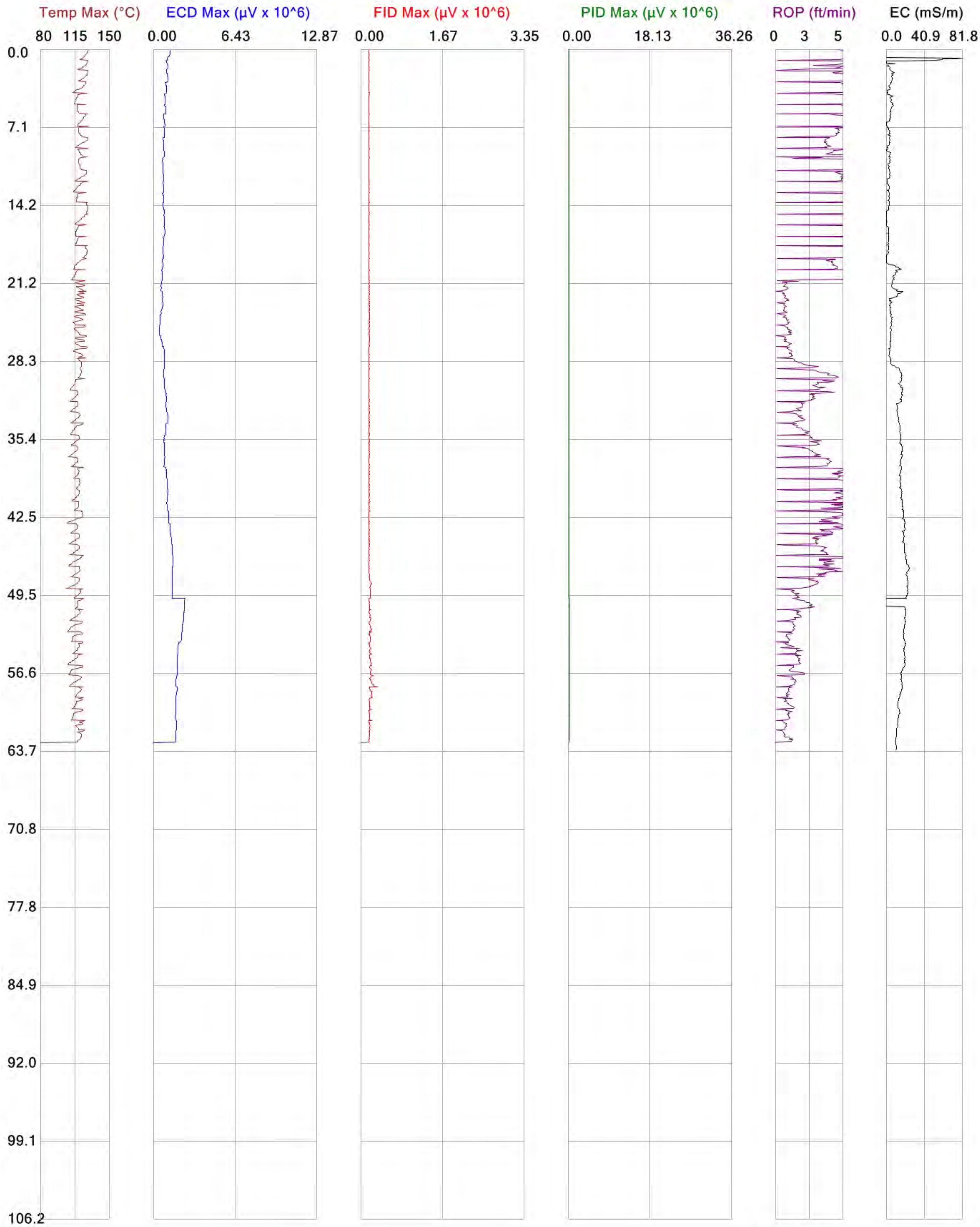

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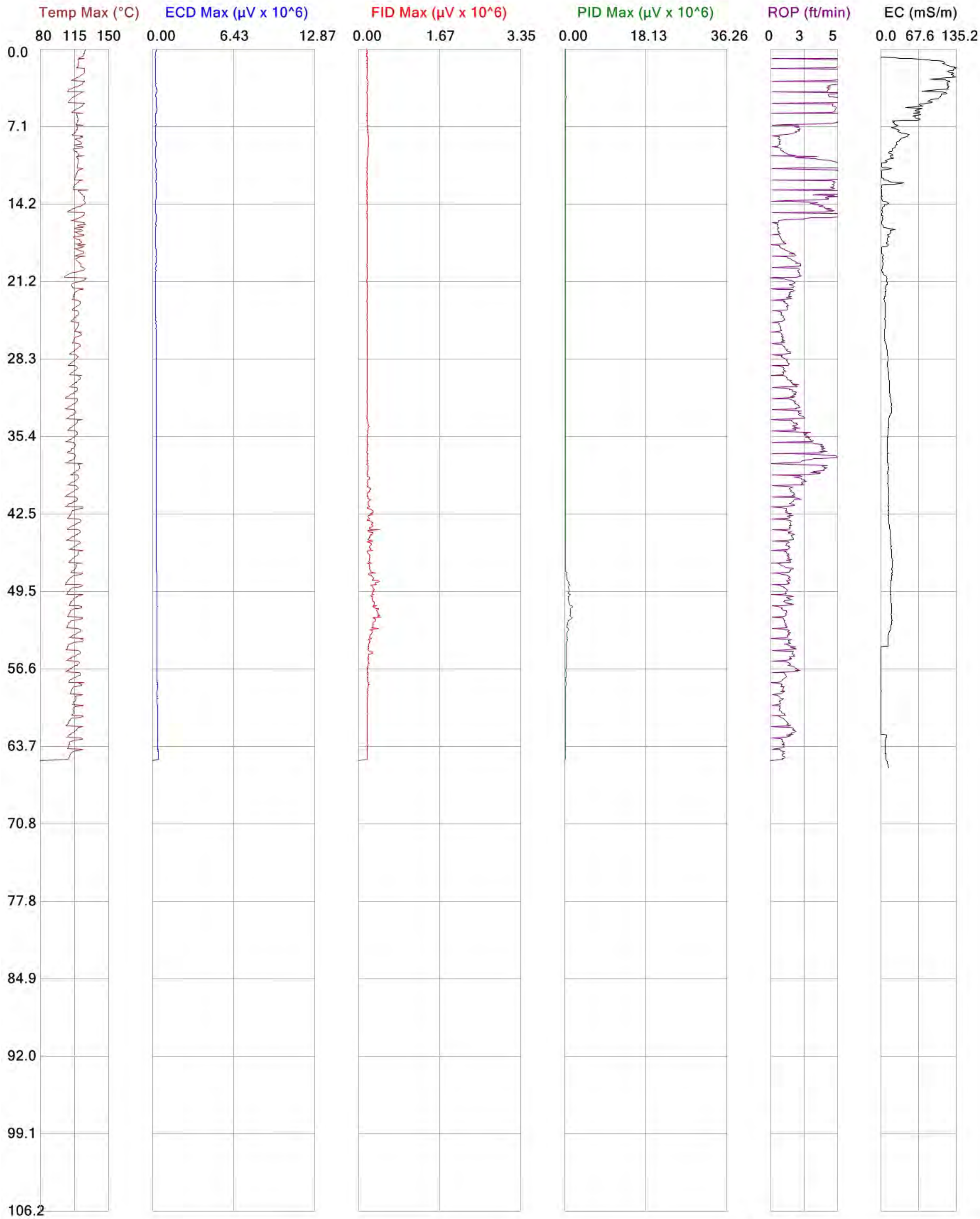

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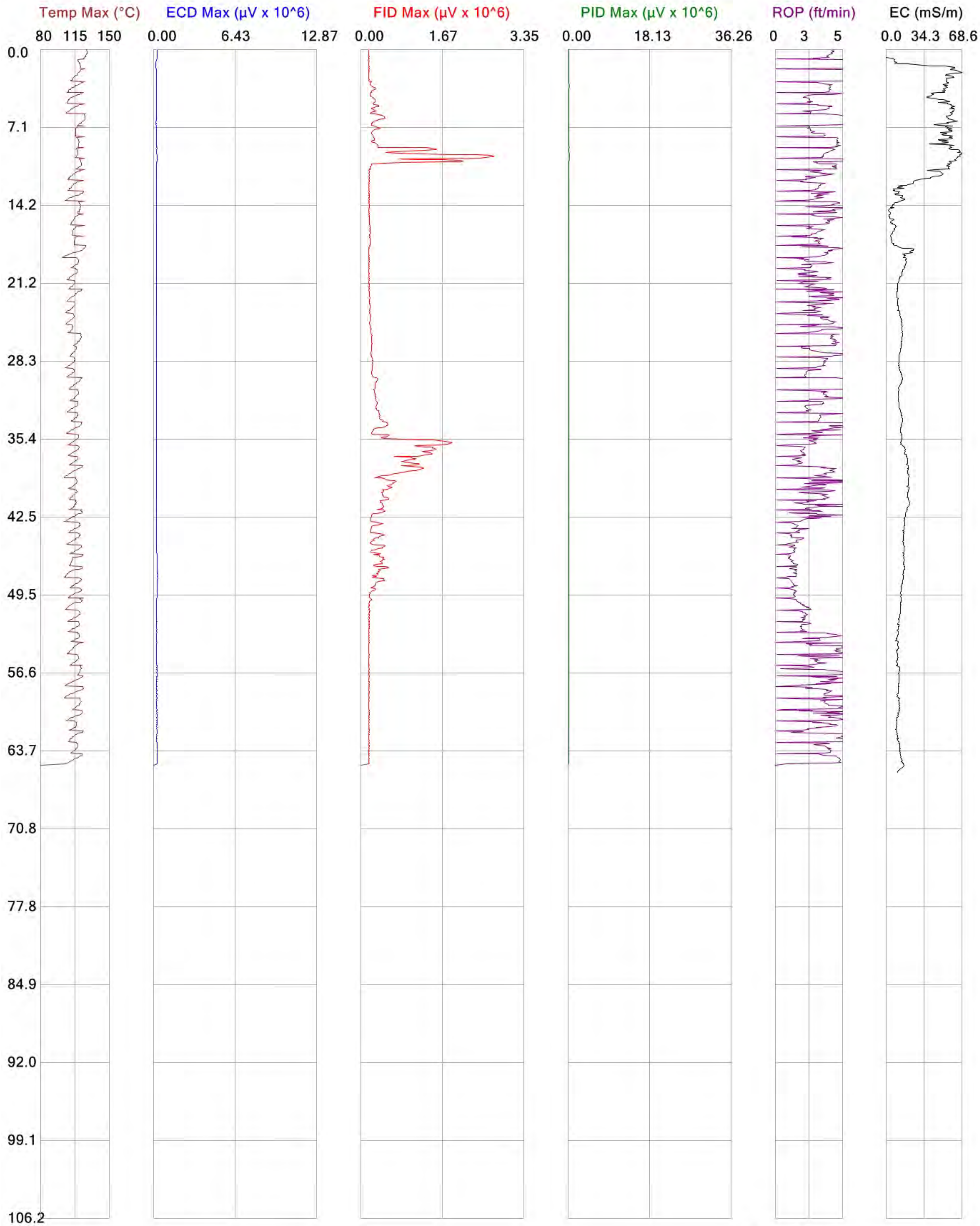

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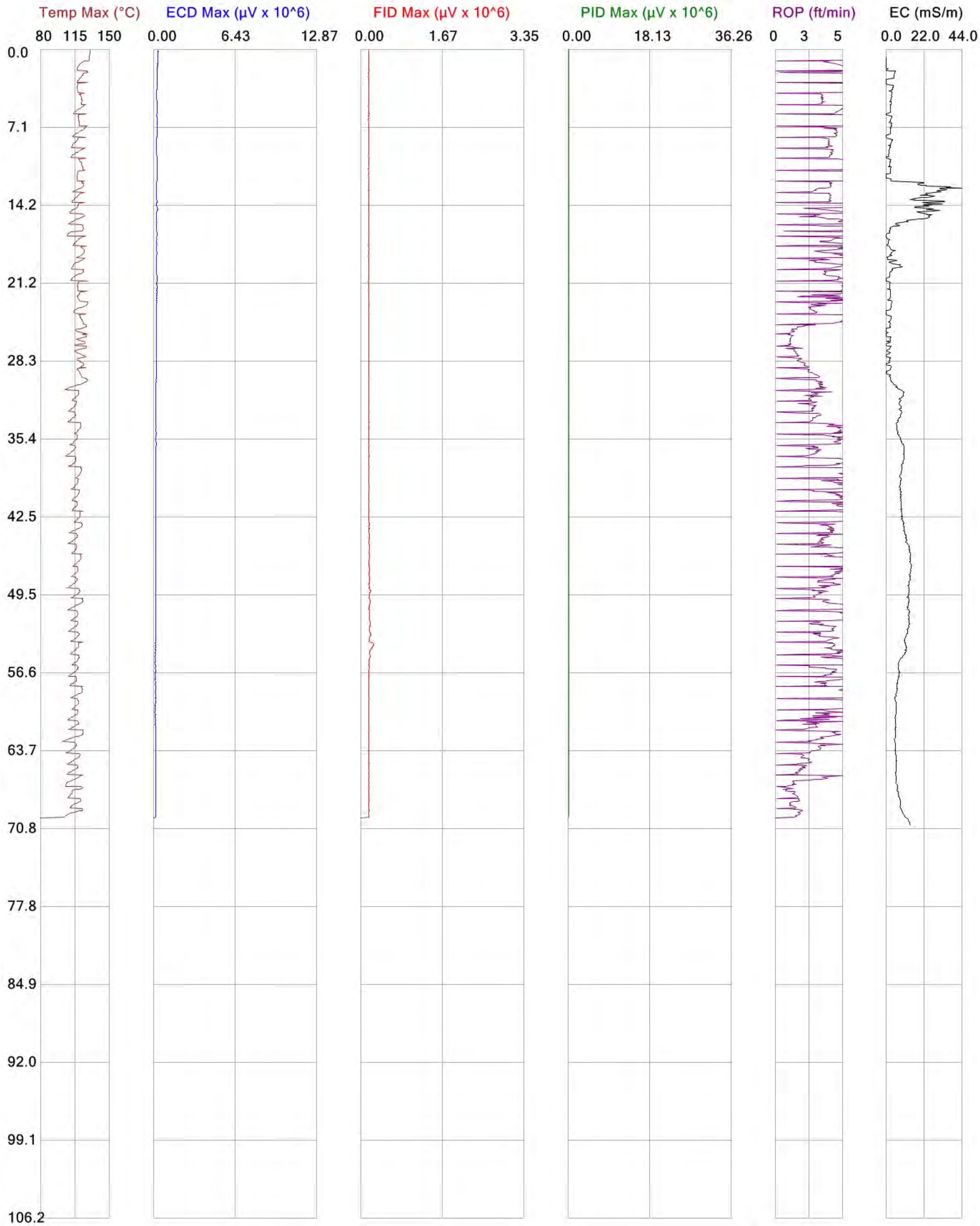

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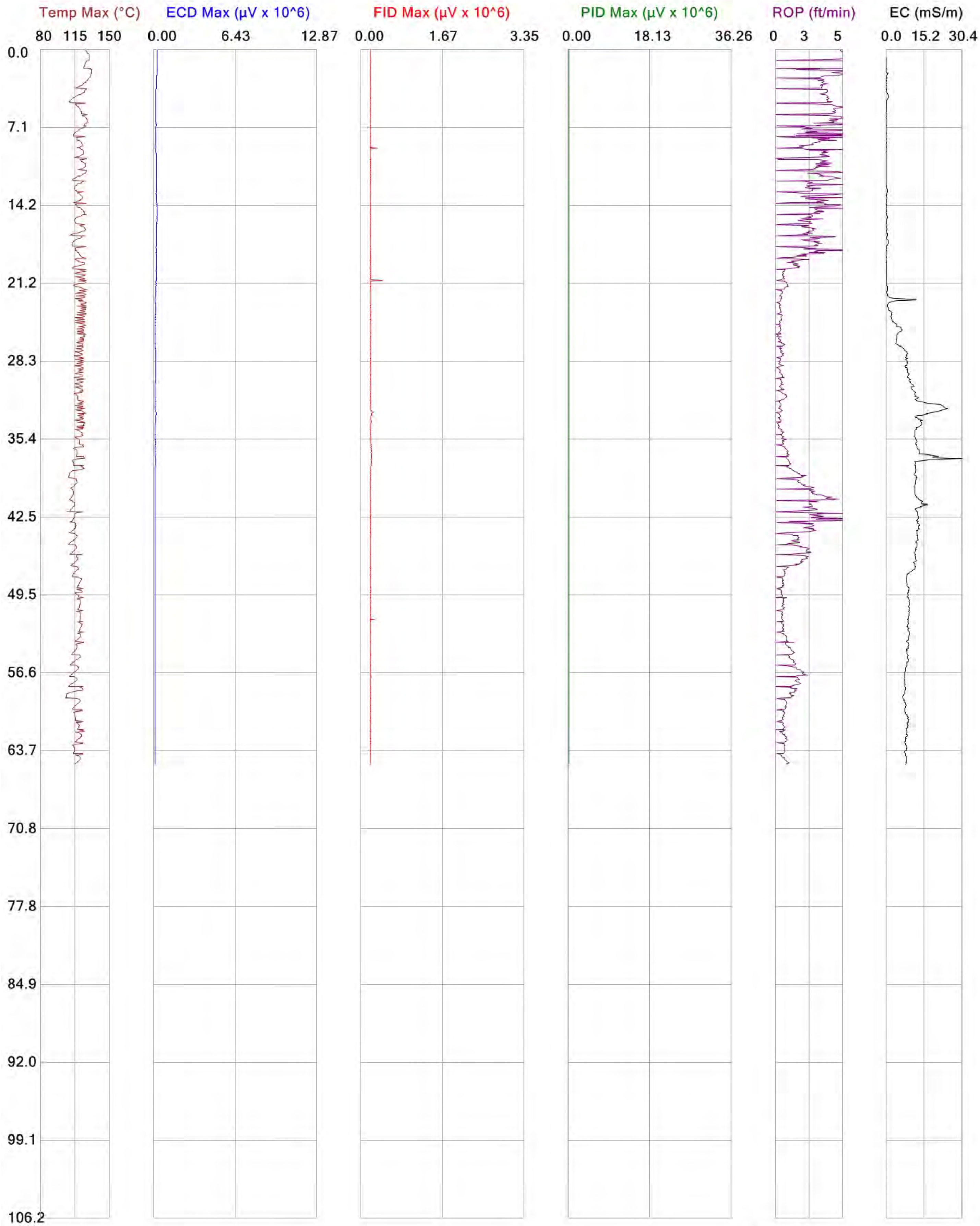

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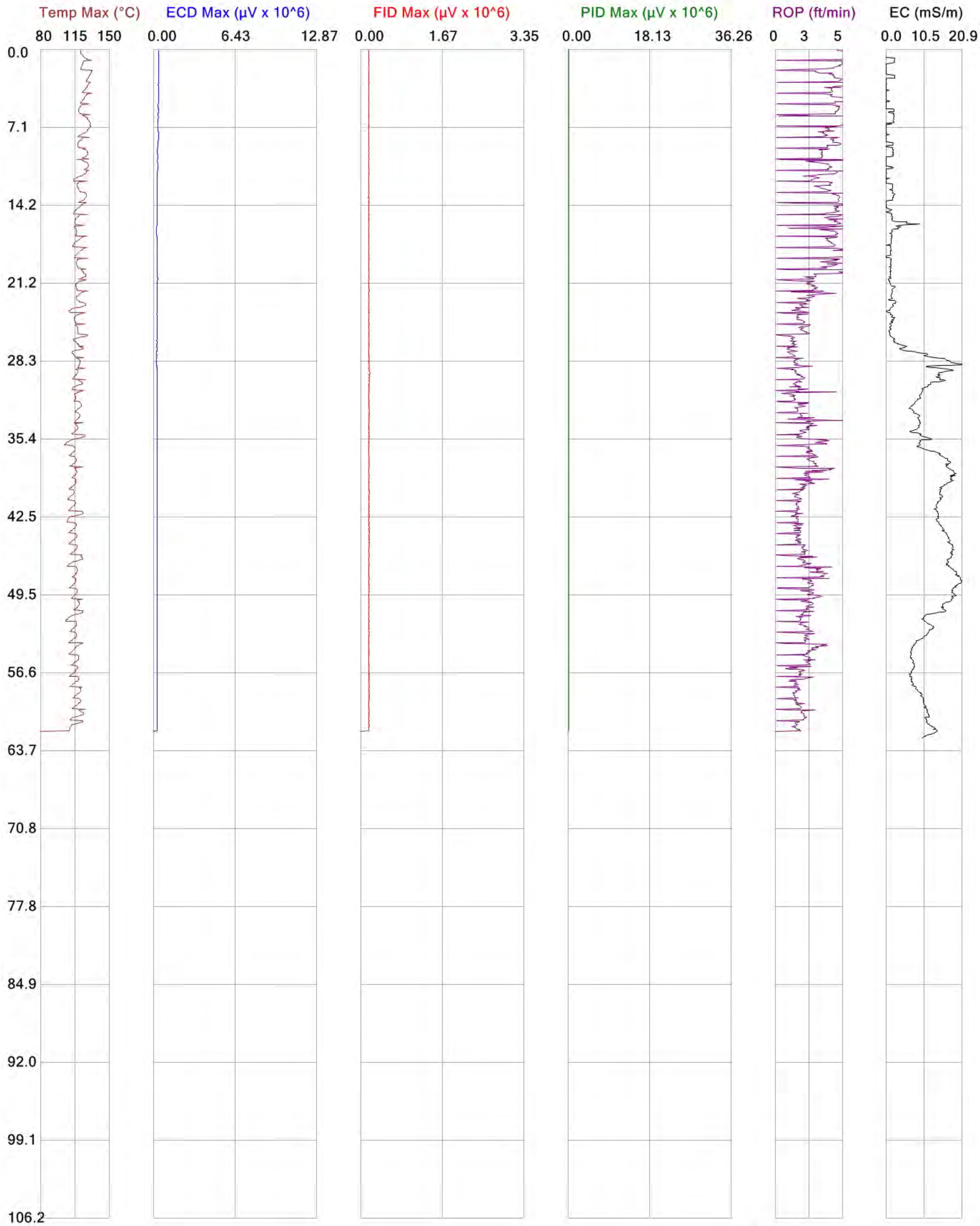

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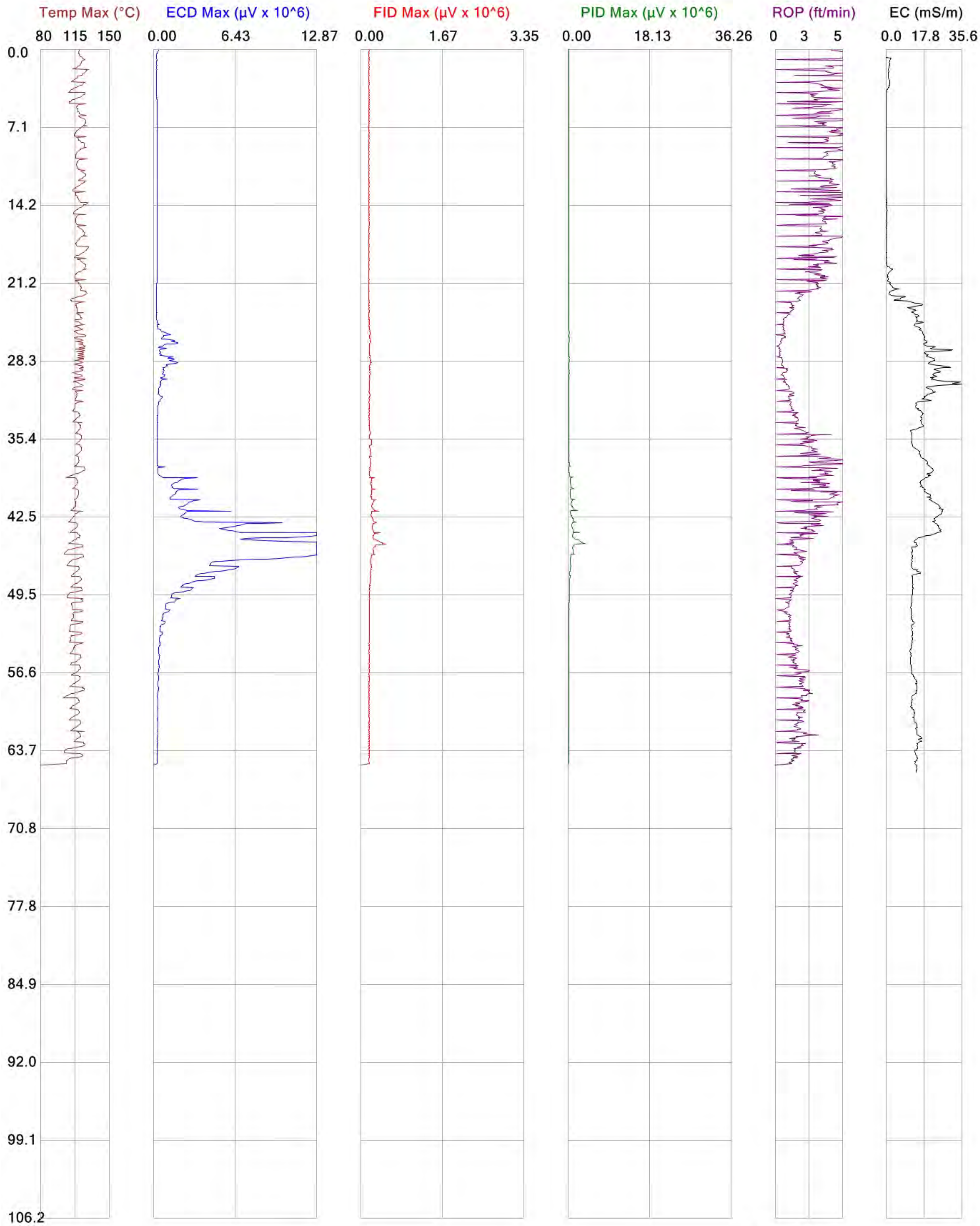

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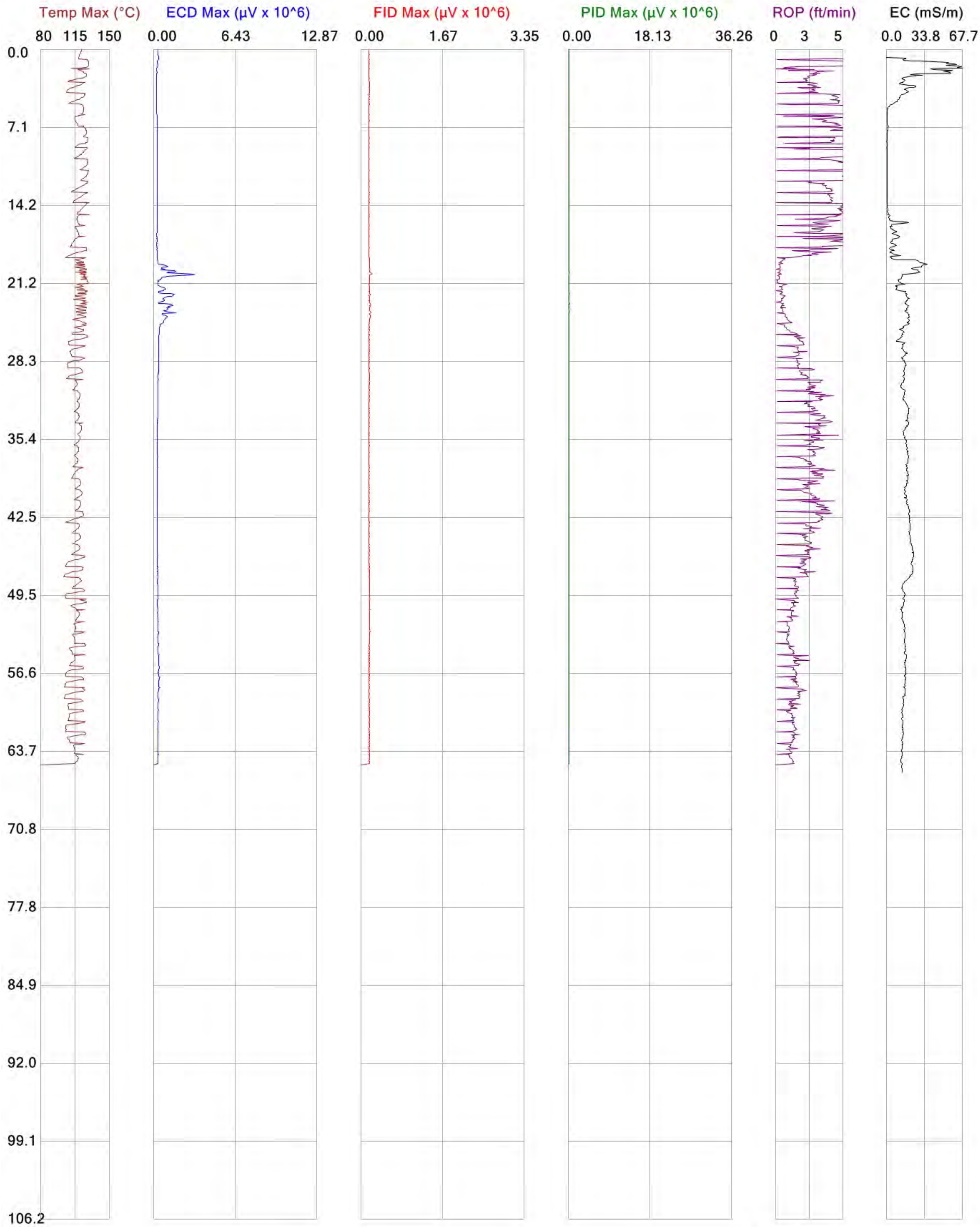

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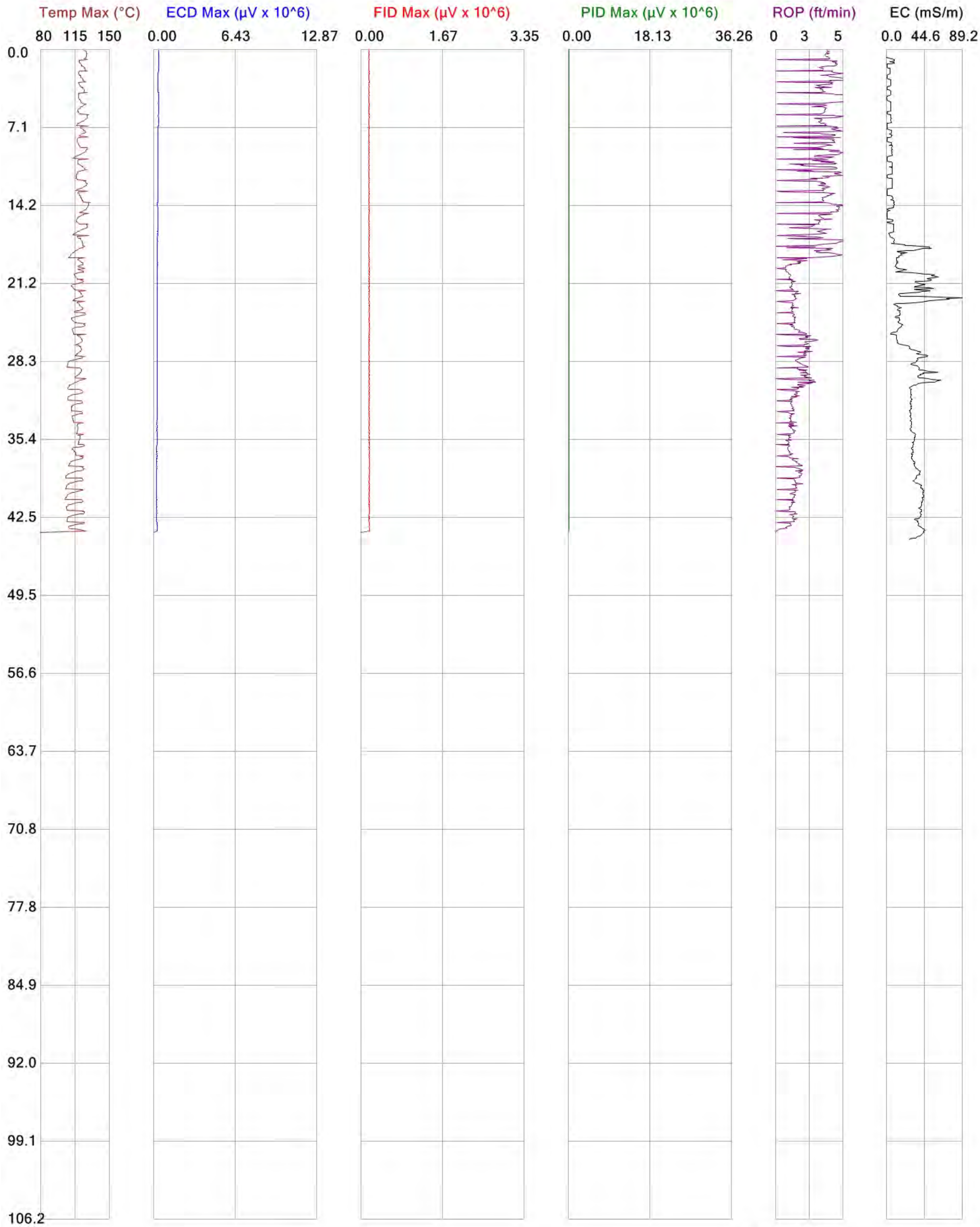

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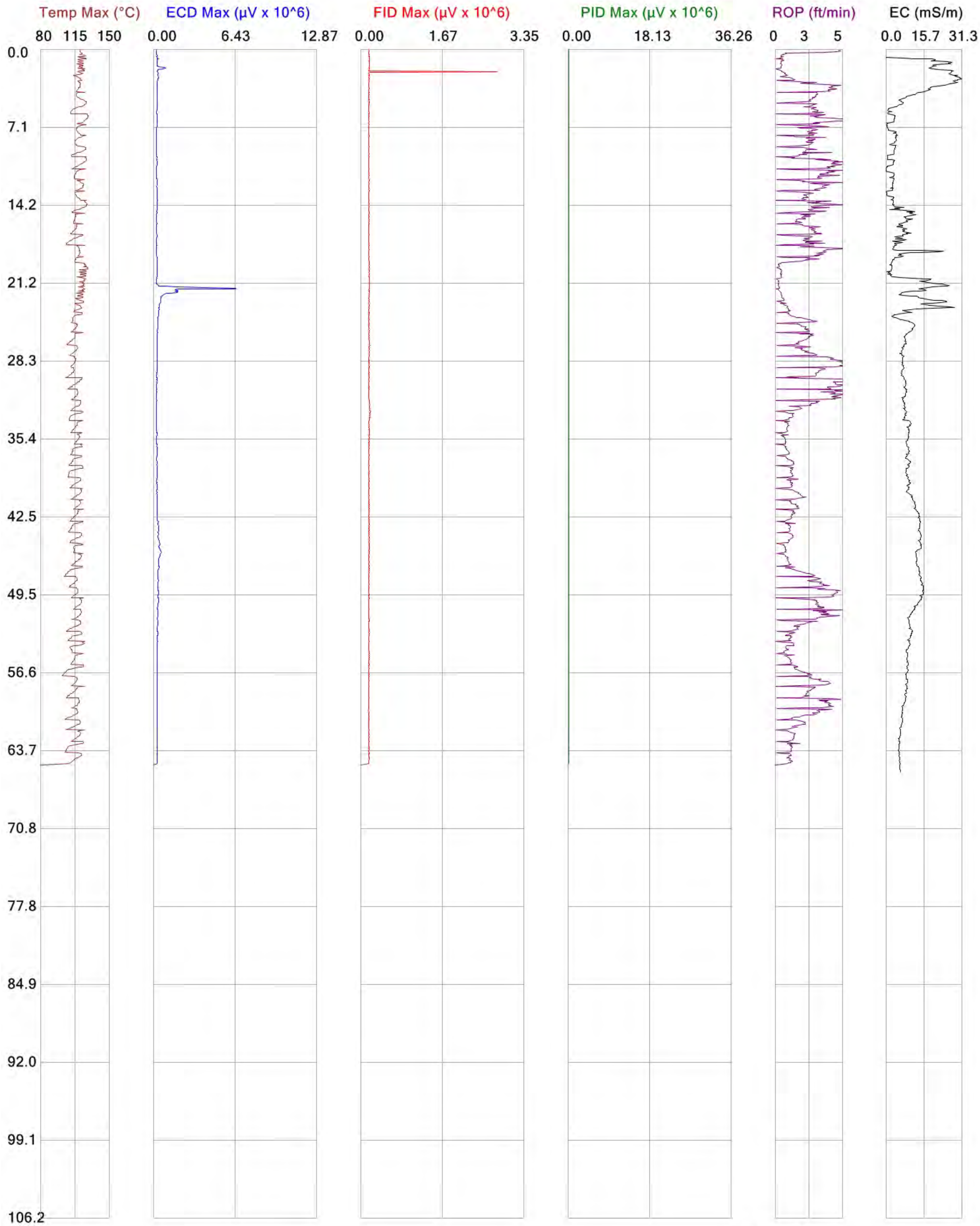

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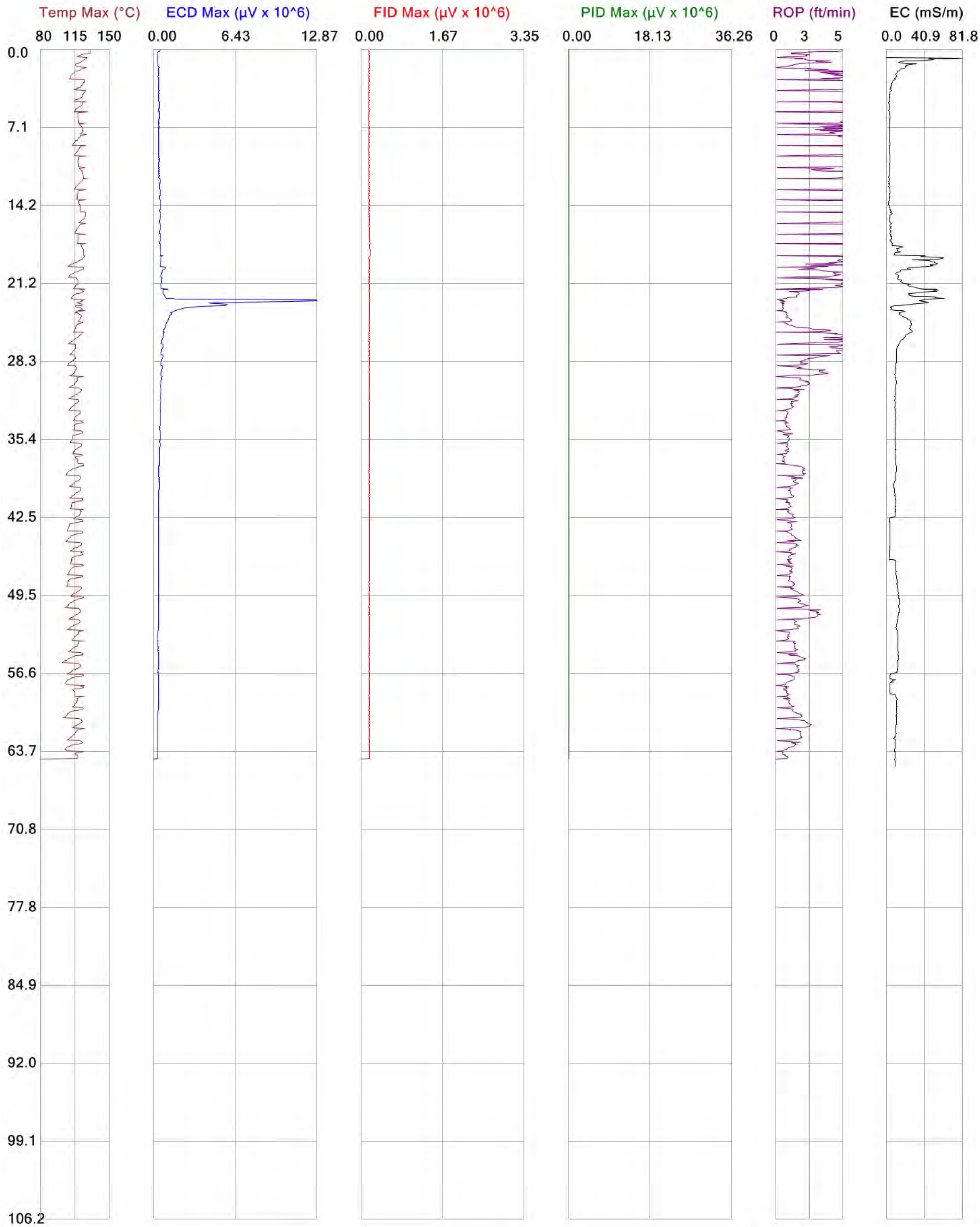

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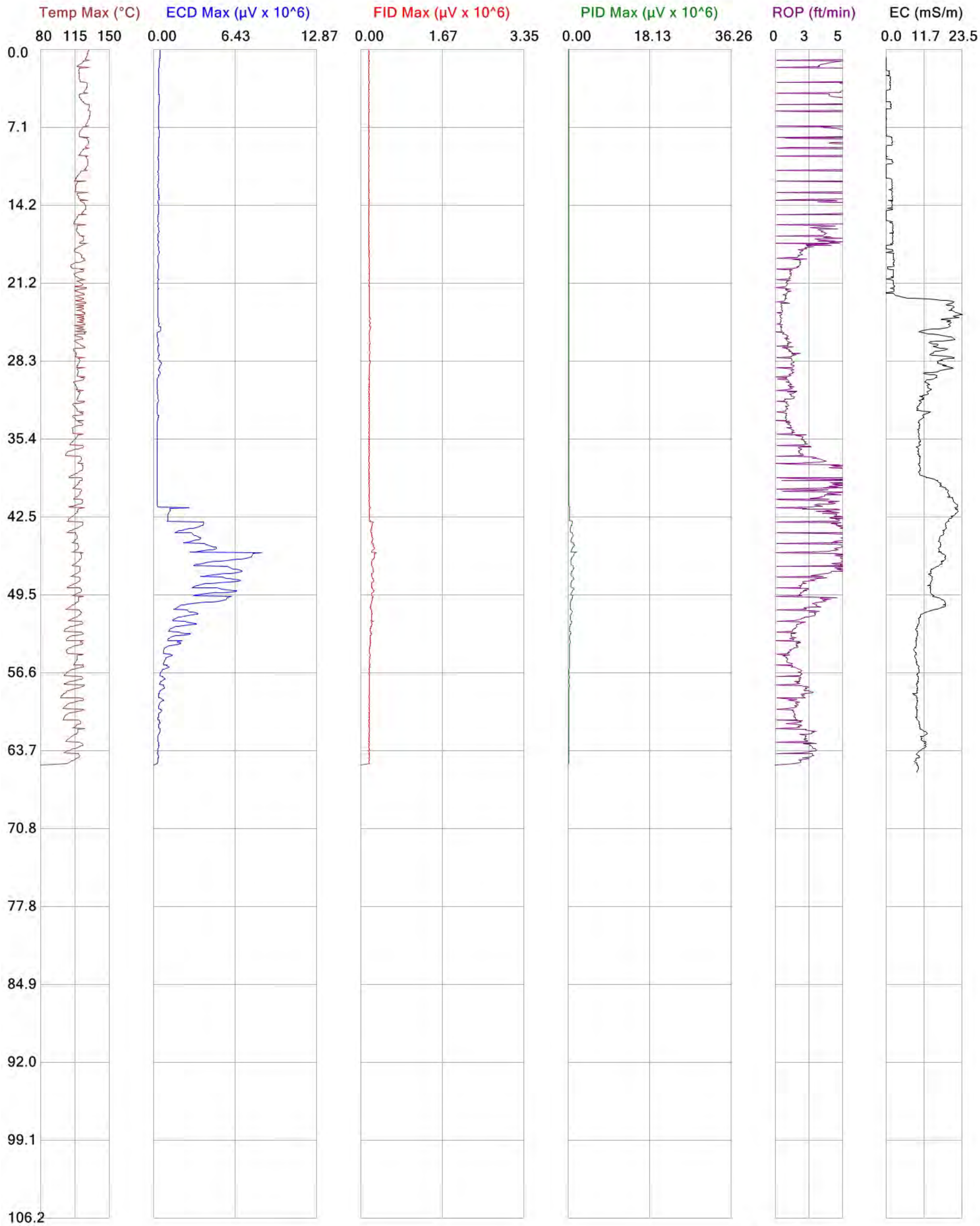

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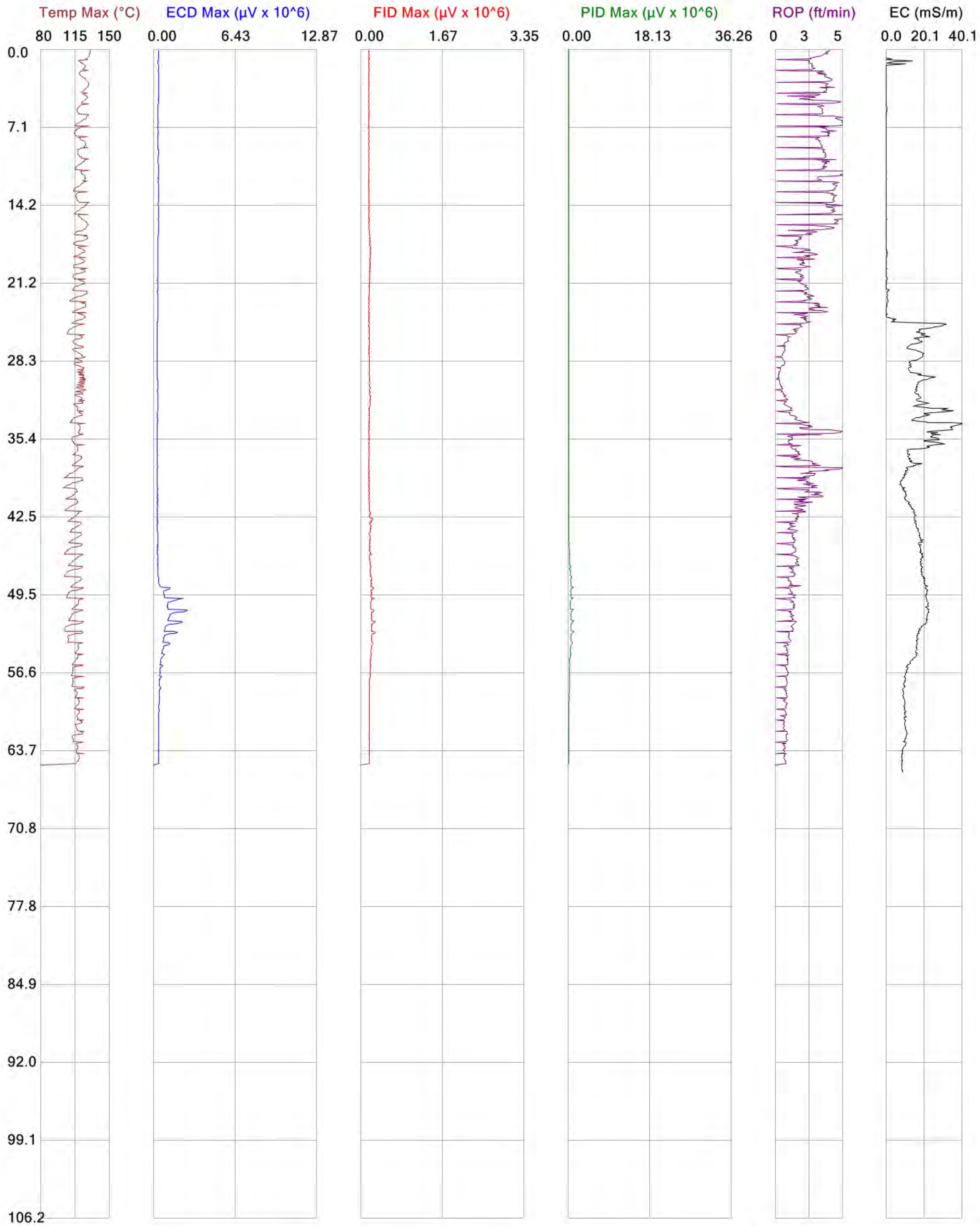

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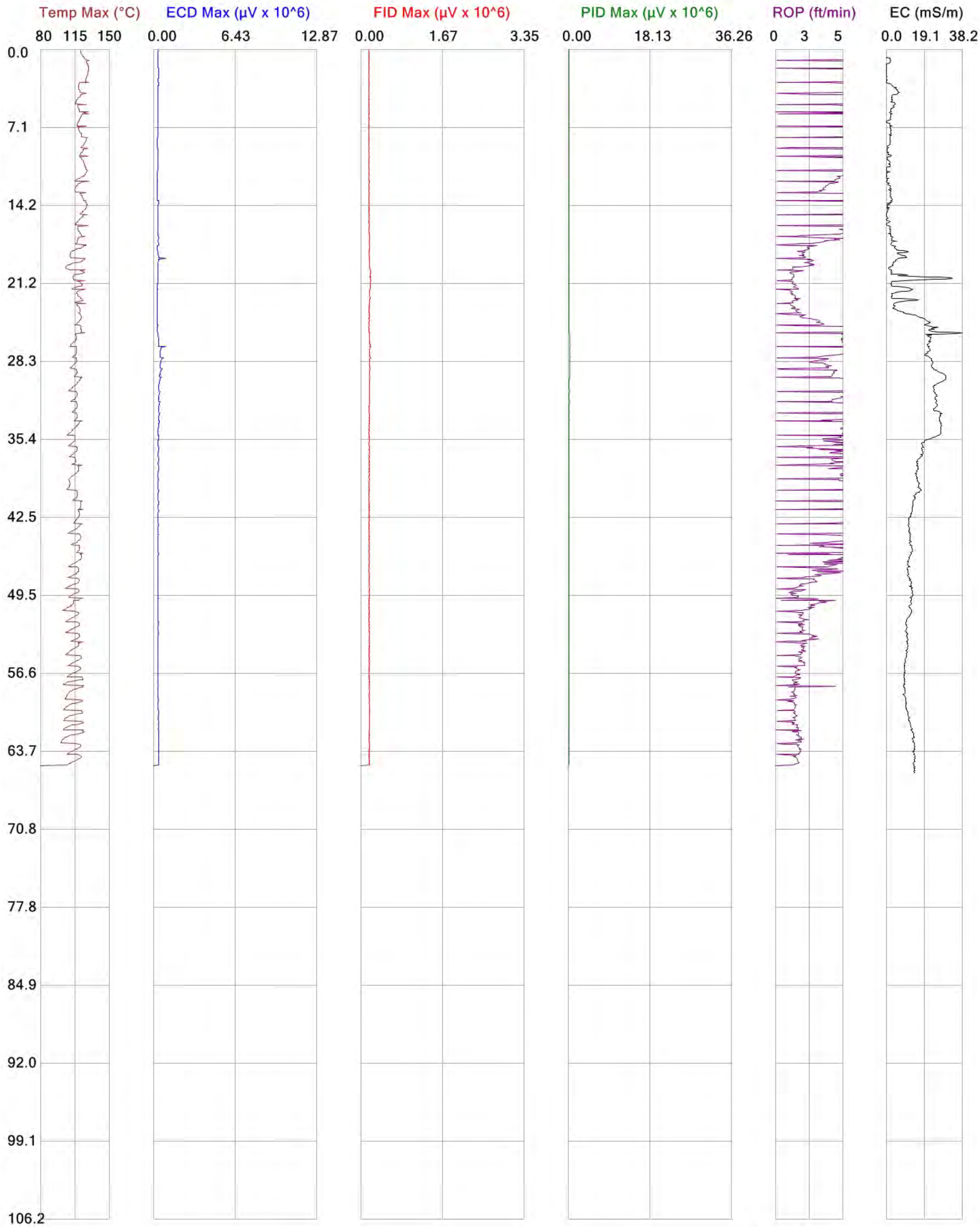

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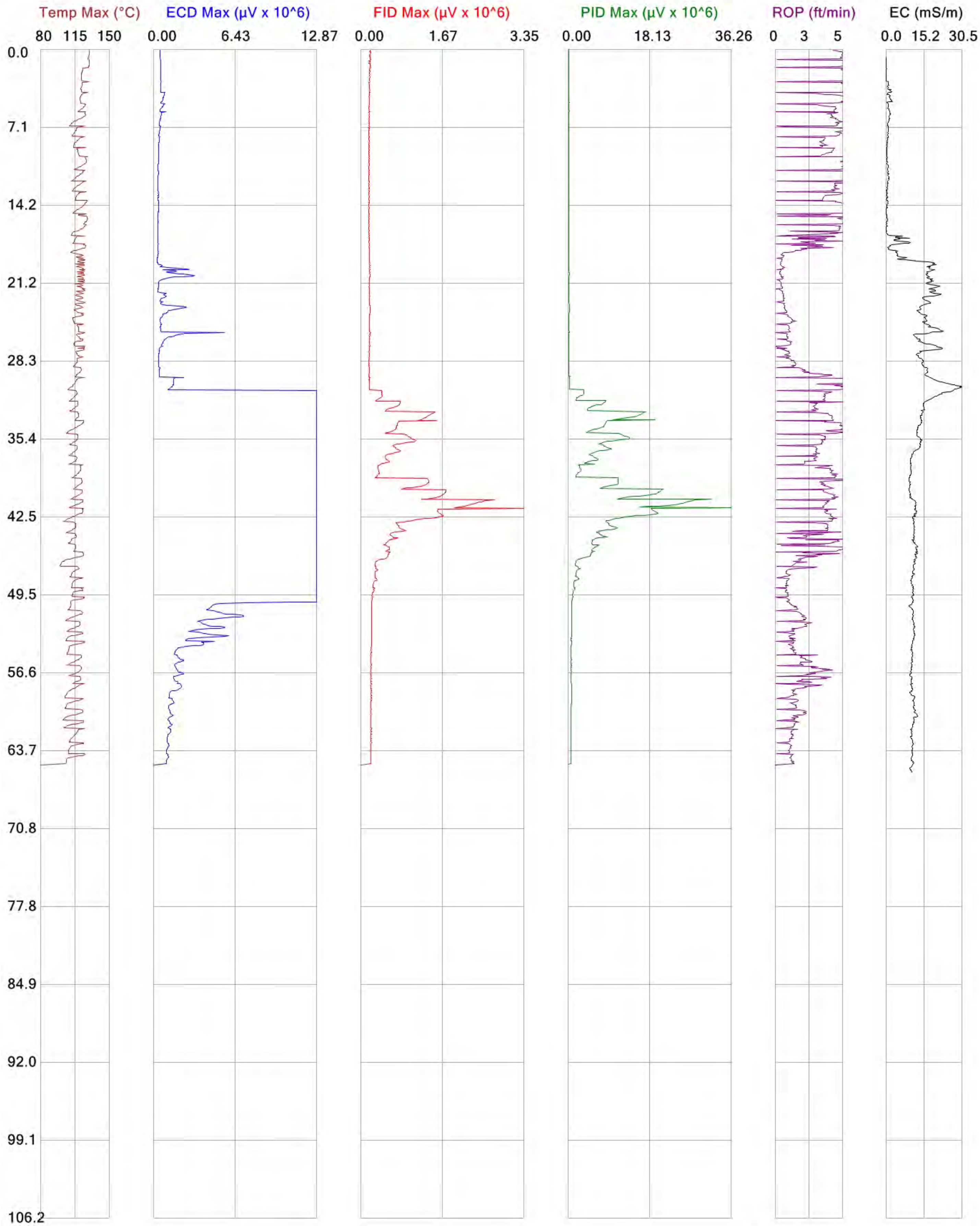

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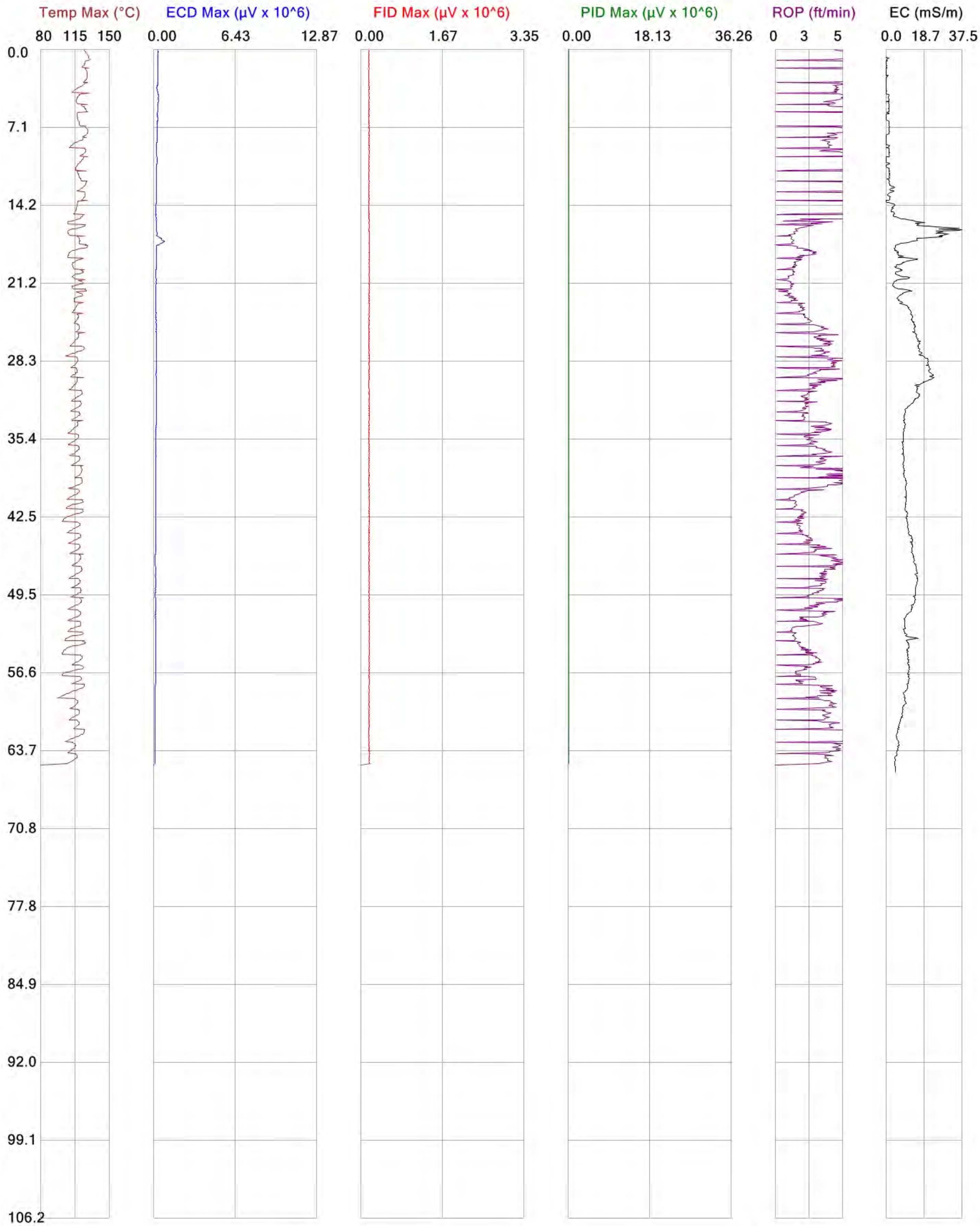

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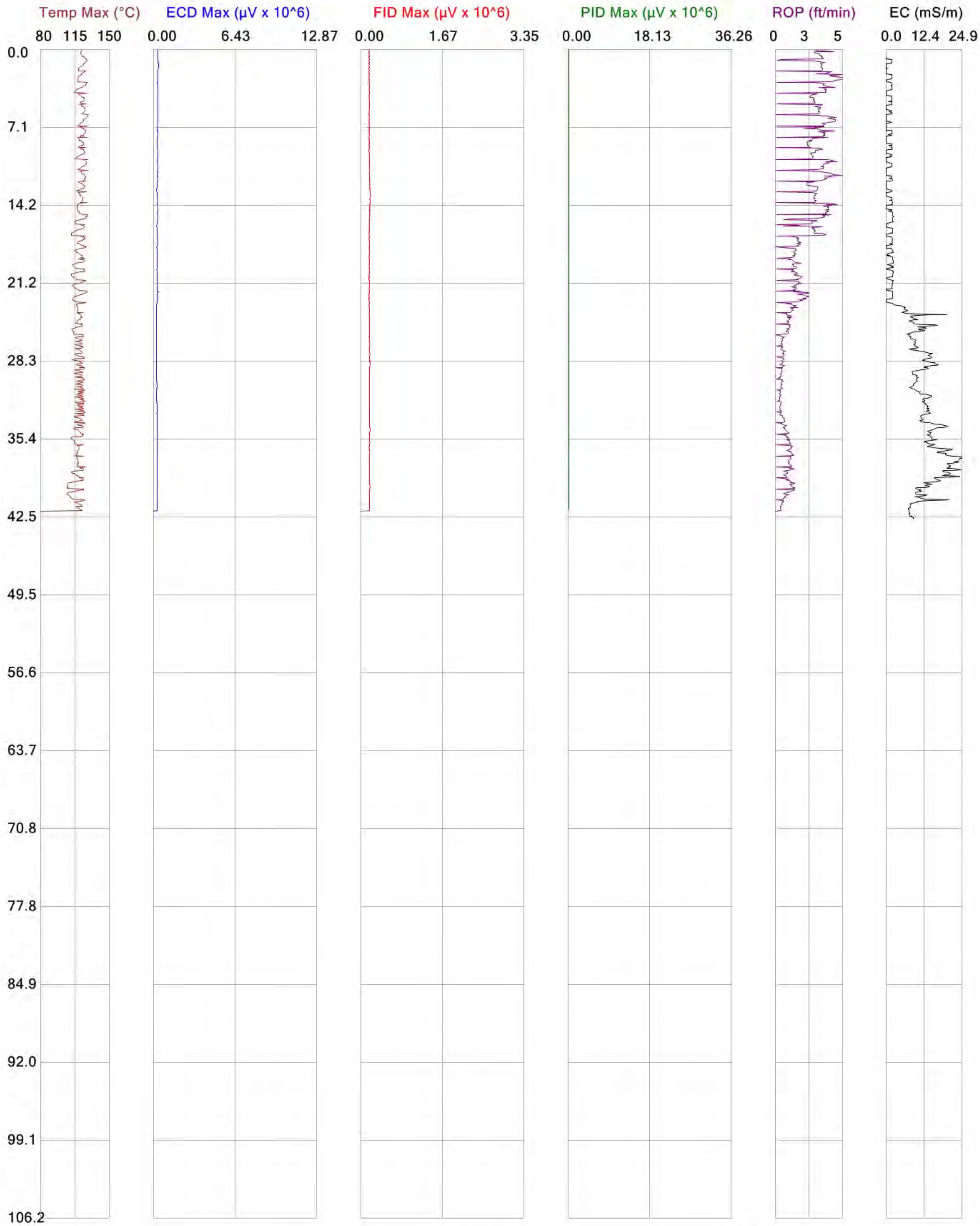

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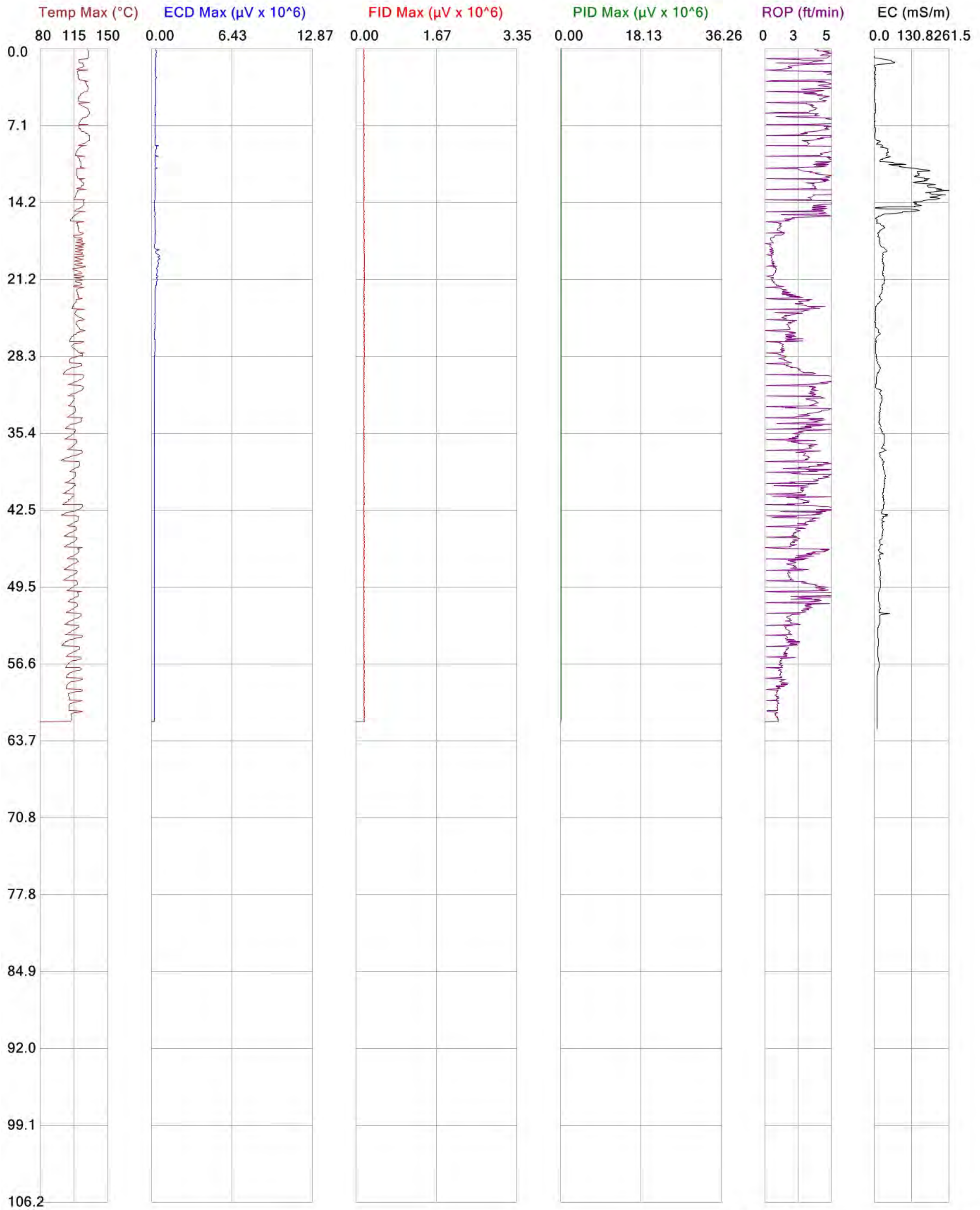

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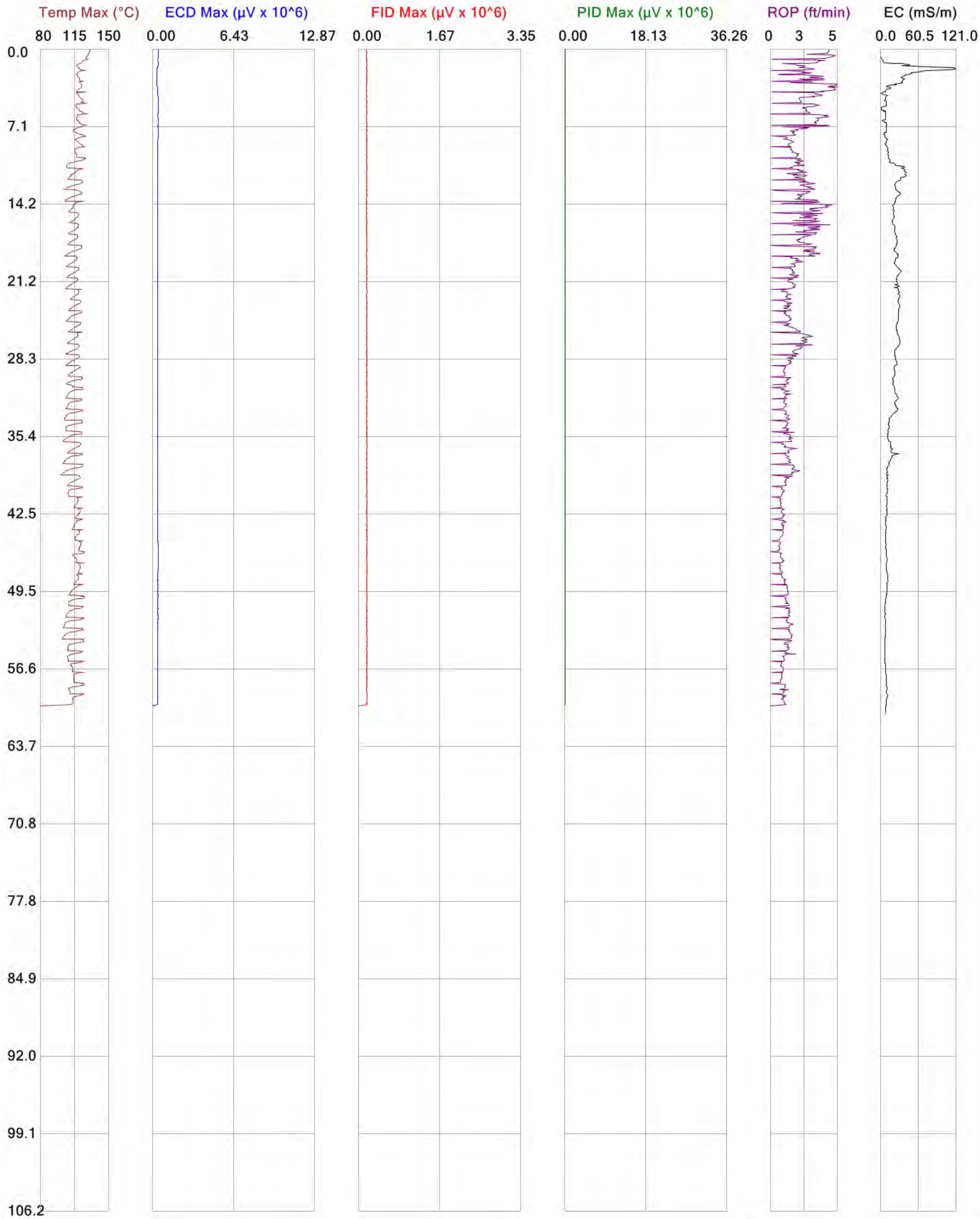

COLUMBIA TECHNOLOGIES

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Project ID: Bofers Nobel	Location:

Appendix B: MIP Field Notes

"Rite in the Rain"®
ALL-WEATHER WRITING PAPER

ALL-WEATHER
ENVIRONMENTAL FIELD BOOK

Name Michael Froio
NewFields
Address PO Box 480309
Charlotte, NC 28269
Phone 704-607-7469

Project Bofors, Muskegon MI
5307 Evanston Ave
Muskegon, MI

This book is printed on "Rite in the Rain" All-Weather Writing Paper - A unique paper created to shed water and enhance the written image. It is widely used throughout the world for recording critical field data in all kinds of weather. For best results, use a pencil or an all-weather pen.

Specifications for this book:

Page Pattern		Cover Options	
Left Page	Right Page	Polydura Cover	Fabrikoid Cover
Columnar	1/4" Grid	Item No. 550	Item No. 550F

CONTENTS

PAGE	REFERENCE	DATE

Reference Page Index

CONTENTS

PAGE	REFERENCE	DATE

Location Muskegon, MI Date 9-19-11

Project / Client Bofors

- Leave hotel @ 7:00; stop @ WalMart for supplies and arrive site @ 7:40
- Columbia on site; Mateco arrives @ 7:55
- Onsite: Fiori - NewFields; Rob Peskey - Mateco;
  Doug McInnes - Columbia Technologies
- Weather: cloudy, rain ~65°
- drive to first location and setup for first MIP boring (MIP 1)
- picked up Mini Rae 2000 (PID) that was sent from AIR so we can take periodic measurements in the breathing zone.
- begin MIP-1 @ 11:00 am; hit very hard sand ~37-38' and could not probe any further; we will attempt to drill / probe a pilot hole past the hard zone to see if we can get past it. Rod has to transported from Grand Rapids. Rods arrive @ 2:20; will unload, set up and try to drill through hard sand layer. Start drilling @ 2:30; could not get deeper than ~45 ft and we need to get to ~47-48 ft; drillers ordered a smaller tip for the rods and it will be in tomorrow morning and we will try it with the smaller tip; moved over to MIP-2 location
- begin MIP-2 @ 3:00 pm; several FID spikes in upper 30 ft.
- Dave and Debbie stop by; Dave provides new keys (American E2542) for the 6 mon wells Lindsey requested.

MIP-2 probing getting more difficult @ 26-28 ft.; refusal @ 39.5 feet; probe rods deconed with an alconox and water wash upon removal. Will probe @ this location tomorrow after receiving the smaller probe tip.

[signature] 9-19-11

Location Muskegon, MI Date 9-19-11/ 9-20-11
Project / Client Bofors

- cleanup and leave site @ 4:40 and arrive hotel @ 5:00
  total time = 10 hrs.

[signature] 9-19-11

Tuesday, Sept 20, 2011

- Leave hotel @ 8:40 and arrive site @ 9:05; Rob (Mateco) arrives @ 9:20; probe tip (small tip) not in yet so we will set up to probe @ MIP-7; Doug (Columbia) arrive @ 9:30;
- start probing @ MIP-7 @ 10:15 am
- weather: sunny, mid 60's
- @ MIP-7, we hit hard sand (refusal) @ 43.20 feet; will pull rods and try to probe through sand when small tip arrives
- moved to the other side of fenceline and set up to probe MIP-6; begin MIP-6 @ ~~11:15~~ AM 13:30; hit hard sand (refusal) @ 33.5 ft @ 14:25
- moved to MIP-5 location and start probing @ 15:00; hit hard sand @ 34.4 ft @ 15:55.
- grouted all the MIP borings before leaving (with bentonite pellets/granules)
- close and lock gate and sign out @ 5:05.
- arrive hotel at 5:30; total time = 9 hrs

[signature] 9-20-11

Location Muskegon, MI Date 9-21-11
Project / Client Bofors

Wednesday, Sept 21, 2011

- Leave hotel @ 7:20 and arrive site @ 7:50; Rob (Mateco) on site; Doug (Columbia Tech) arrive @ 7:55; will set up at MIP-1 location and probe down and attempt to get through hard sand - will do this 1-2 ft from original MIP-1 location since that borehole was filled with bentonite pellets.
- weather: p. cloudy ~65°
- begin probing @ MIP-1 @ 8:20 am; decided to pre-probe as deep as we could (based on available rod) so we don't have an issue with the MIP tip; Doug says this should not alter results as the MIP tip is slightly larger than the probe tip; pre-probed to 72 feet; will set up the MIP probe and probe with that; start MIP probing @ 9:25; checked breathing zone around Geoprobe while pulling rods (did this the past 2 days also) and all readings were < 1 ppm; MIP probing going very slowly through hard sand; broke through the hard sand layer ~ 43-44 feet; started seeing a PID spike around 47 feet; probed to refusal @ 103 ft @ 12:15. No other spikes detected.
- pull and clean rods and set up @ MIP-2 @ 3:00 to pre-probe
  Doug had to repair the EC probe/wires.

[signature] 9-21-11

Location Muskegon, MI Date 9-21-11 and 9-22-11

Project / Client Bofors

- pre-probed to 90 ft and stopped @ 3:50; will pull rods in the morning and bore w/ MIP; conference call from 4:00 - 4:30; leave site and arrive hotel @ 5:00

total time = 9.5 hrs

[signature] 9-21-11

Thursday, Sept 22, 2011

- Leave hotel @ 7:20 and arrive site @ 7:45; Rob (Mateco) and Doug (Columbia) on site; Geoprobe is a 6620 DT.
- Weather - mostly cloudy, 58°
- will pull rods at MIP-2 and perform MIP probing; just a note that Doug conducts a performance test before MIP probing @ each location - the test is performed for the PID, FID, EC, ECD and back pressure; start MIP probing @ MIP-2 @ 8:50; hard sand zone from ~ 37-38 ft to ~ 47 ft and was very hard from 42-43 ft; PID and FID response above the sand; ECD response, larger PID response and smaller FID response immediately below the hard sand layer; probed to refusal @ 100.5 ft @ 11:23; will pull and clean rods and move to MIP-7 to pre-probe. Having a mechanical problem w/ geoprobe
- begin MIP-7 pre-probe @ 2:30 pm
  - will attempt to pre-probe and will trade out geoprobe rigs tonight.

[signature] 9-22-11

Location Muskegon, MI Date 9-22-11

Project / Client Bofors

- pre probed to 90 feet; got hard @ ~ 42 feet.
- decon geoprobe before taking it from the site and mark (flag) pump test well locations.
- Leave site @ 5:10 and arrive hotel @ 5:30

total time = 9.5 hrs.

[signature] 9-22-11

Friday, September 23, 2011

- Leave hotel @ 7:20 and arrive site @ 7:45; Doug (Columbia) and Rob (Mateco) arrive @ 7:47; set up to pull pre-probe rods @ MIP-7 and then MIP probe.
- Weather: cloudy, chilly, ~ 50°
- Doug conducts performance test on MIP probe and Rob sets up to pull geoprobe rods; new Geoprobe is a 6610 DT
- Dennis Kufahl and Greg Vanderheide - Moore & Bruggink, Inc arrived @ 8:15 am to survey MIP locations
- begin MIP-7 probing @ 9:20; EC probe issues again @ 46 ft - had to pull rods out to repair.
- Chuck Graff of MDEQ arrived @ 10:45
- Dale Elliott of Mateco arrive @ 10:00 and we walked new well locations w/ Dave; Dale leaves @ 10:50 am; Surveyors leave @ 10:45
- replaced MIP tip and started MIP probing again @ 11:50

[signature] 9-23-11

Location Muskegon, MI Date 9-23-11 / 9-24-11

Project / Client Bofors

- @ MIP-7, hard sand from ~ 41-42 ft to ~ 51-52 ft and saw a spike in the PID @ ~ 52 feet and a spike in the ECD.
- Stopped drilling @ 105 ft; did not hit clay; due to position of rig on a slope, driller did not feel comfortable drilling any deeper so we halted @ 105 ft. Will pull and decon rods. ~ 3:00pm
- cracked a rod on this boring so Doug is going to take that one out and re-string the remaining rods.
- Conference call 4 - 4:15; Chuck (DEQ) leaves @ 3:15
- we have a sand lock in the rods; will work that out then move over to MIP-6.; removed rods and sand lock, but due to time, will start MIP-6 in the morning.
- leave site @ 5:40 and arrive @ hotel @ 6:00

total time = 10 hrs.

M[signature] 9-23-11

Saturday, September 24, 2011

- leave hotel @ 7:25 and arrive site @ 7:45; Rob and Rich Crosby (Matecs) on site; Doug arrives @ 8:00 am
- Weather: p. cloudy ~ 55°
- will set up to pre probe @ MIP-6; start pre-probing @ 8:35; Geoprobe 6610DT

M[signature] 9-24-11

Location Muskegon, MI Date 9-24-11

Project / Client Bofors

- Doug conducts performance test on MIP probe
- hit hard sand layer ~ 34 feet; probed to 100 ft @ 9:20; will pull and clean rods and then begin MIP probing.
- geoprobe rods out and cleaned by 9:45; begin MIP probing @ 10:00 am; hard zone appears to be from 34-52 feet but zone not nearly as hard as in other borings - did not have difficulty drilling though; PID and FID spikes under this zone but not as large as those @ MIP-1 or 7 and no response from ECD probe; hit the lower clay ~ 103 ft and no additional spikes from the detectors; will pull and clean rods; start pulling and cleaning rods @ 12:20; rods pulled and cleaned @ 13:00; drillers take break for lunch 13:00 - 14:00.
- fill MIP-6 with Benseal granules.
- begin pre-probing @ MIP-5 @ 14:00; started getting hard ~ 29-30 ft bgs; harder yet ~ 34 ft (top of hard sand); could not tell where it became easier or where we came out of the hard sand; preprobed to 100 ft @ 14:50; pulled and cleaned rods and started MIP-5 @ 15:15; FID response from ~ 49-60 ft; no response from PID or ECD; got down to 63.65 ft and a thunderstorm was approaching (lightning & thunder in area) and the drillers are required to stop. Due to the time (16:40)

M[signature] 9-24-11

Location Muskegon, MI Date ~~9-24-11~~ 9-25-11
Project / Client Bofors

We decided to pull the MIP rods, cover the hole and resume tomorrow from that depth down; pull rods 16:40 - 17:00; at the 63.65 ft depth, the ECD and PID were still flat and the FID had dropped basically to background; cover hole and leave site @ 5:10 ; arrive hotel @ 6:00 .
total time = 10 hrs
stop @ WalMart for supplies

[signature] 9-24-11

Sunday, September 25, 2011

Leave hotel @ 7:20 and arrive site @ 7:45 ; Doug (Columbia) and Rich (Matrix) on site ; weather - light rain and cool, ~52°. Since it rained all night and it was still raining, we were concerned that the Columbia van would get stuck in the grass/sand on the west side of the fence and since it is Sunday, Dave is not here to push us out. So we decided to move back to the east side where we can remain on the road and will work @ location MIP-15. We will leave MIP-5 open and covered until we can talk w/ Jim about whether it is necessary to complete that boring as we were past the area of detections per the other borings. Rain has stopped (for now) 8:20.

- Set up @ MIP-15 and started pre-probing @ 8:52; Started to get hard @ ~29 feet; harder ~34 feet.

[signature] 9-25-11

Location Muskegon, MI Date 9-25-11
Project / Client Bofors

- Complete pre-probing @ 9:30 and pull and clean rods until 9:50 ; begin MIP probing @ MIP-15 @ 10:00 ; FID and PID spikes ~38-40 ft and ECD spike begins @ ~46 ft ; PID and ECD spikes are the largest we have seen so far; hard zone at this location appears to be ~30-35 feet; all responses back to baseline ~58 ft ; PID spikes ~40 to 55 ft ~~for~~, ~40-58 for FID and ~46 to 56 ft for ECD ; hit clay ~103 ft @ 12:40; will pull rods, clean rods and then move to another location; pulled and cleaned rods 14:15; several rods (3) were cracked so Doug will trade them out with extra rods and re-string for MIP boring tomorrow; Set up @ MIP-8 (still can't go west of fence due to wet conditions and driller said he needed more material moved to get to MIP-11 and 3 and we will have Dave do that this week) so we decided to drill MIP-8.
- Set up to pre-probe MIP-8 @ 14:35
- filled MIP-15 with Benseal granules
- @ MIP-8, Rich said it started getting hard @ 34.5 feet and harder @ 38 feet ; I assist Doug in re-stringing the rods ; Rich said it was not evident if/when he got out of the hard sand.

[signature] 9-25-11

Location Muskegon, MI Date ~~9-25-11~~ 9-26-11

Project / Client Bofors

- pre probed to 100 feet @ 3:30; Rich leaves site @ 15:40; Doug repairing MIP lines; leave site @ 16:10 and arrive hotel @ 16:25
total time = 9 hrs.

[signature] 9-25-11

Monday, September 26, 2011

Leave hotel @ 7:20 and arrive site @ 7:40; Rich (Mateco) on site; weather - windy, cloudy, scattered rain ~62°; Doug (Columbia) arrives @ 8:05; pull rods from pre-probe 8:10 - 8:35; begin MIP boring @ MIP - 8 @ 8:50; Doug conducted performance test before boring; really hard zone ~37.5 to 39 feet then probing became easier; spikes in PID, FID and ECD from ~34 ft to 51 ft then they all dropped back to baseline; since everything had dropped to baseline we decided to go to 2-ft pushes with a 30 second pause instead of the normal 1 ft push with 30 second pause; we started the 2-ft pushes @ 62 feet; time was 10:15; down to 90 feet @ 10:43; I left to meet up w/ Dave for a conf. call; Doug and Rich will continue; pump test conf. call @ 11:00 - 12:00; back to MIP-8; they completed MIP-8 to 102 ft and hit clay @ 98 feet; upon return Doug informed me

[signature] 9-26-11

Location Muskegon, MI Date 9-26-11

Project / Client Bofors

that while pulling rods, they separated and they will now work to retrieve what they can; Doug will then need to do some repairs before we can move to the next boring; Doug completed repairs and conducted performance test ~1:50; Dave and Debbie came out with loader to flatten areas to drill @ MIP-16 and MIP-11; we covered MIP-8 with a drum and will leave it open until the week of Oct 10 when we are here drilling pump test wells and will then overdrill @ MIP-8 to attempt to retrieve the tip (all other rods were retrieved); Set up @ MIP-16 @ 14:20 to pre-probe; started getting hard @ 25 ft and harder yet @ 37 feet; pre-probed to 108 feet and did not feel like we hit the till; Doug and Rich cleaned up and leave site @ 15:45; I stay for conference call @ 4:00; per conf. call, we can postpone MIP-5; for tomorrow, complete MIP-16 then move to MIP-25 then MIP-26. Conf call 4-4:45; go talk to Dave then sign out and leave site @ 17:15 and arrive @ hotel @ 17:40

total time = 10 hrs.

[signature] 9-26-11

Location Muskegon, MI Date 9-27-11
Project / Client Bofors

Tuesday, September 27, 2011

Leave hotel @ 7:25 and arrive site 7:45; Rich (Matecco) on site; will complete MIP-16; weather - cloudy, light rain and 52°; Doug (Columbia) arrive @ 8:05; pulled and cleaned geoprobe rods 8:10 - 8:40; begin MIP probing @ MIP-16 @ 8:45; from conf call yesterday, everyone agreed that if we get past the peaks we can stop @ 65-70 ft and we don't need to try to tag the underlying till; marked MIP-25 and MIP-26 locations; PID spike from 38-50 ft; FID spike 32-54 ft; ECD spike from 40-52 ft; all detectors returned to baseline ~55-~~56~~ ft; we continued to 65 ft and no other detections so we stopped @ 65 ft @ 10:05; pulled and cleaned MIP rods 10:10 - 10:50; set up @ MIP-26 @ 11:10 and begin preprobing @ 11:20; hit hard sand ~ 20 ft and it remained pretty hard; a little softer @ 52 ft; pre-probed to 80 ft; pulled and cleaned rods and started MIP probing @ 13:35; had to stop @ 21.3 ft as we could not advance probe; very hard; we will pre-probe through same hole with a slightly larger tip down to ~ 52 ft and try the MIP probing again;

Filled MIP-16 w/ Bentonite granules.

Mueller 9-27-11

Location Muskegon, MI Date 9-27-11
Project / Client Bofors

large ECD spike ~ 19-21 ft and slight/small response on PID and FID; ~~while~~ While pre-probing with larger tip, the hard zone appeared to be from 20 - 36 feet; pulled and cleaned pre-probe rods and begin MIP probing @ 26 @ 14:55; based on MIP probing, the really hard zone appears to be 20 - 26 feet; large ECD spike ~ 20 - 26 ft and very small PID and FID around 23 ft but they were barely detectable; much easier to push probe after 26 feet; probed to 65 feet and no PID response so we stopped; will pull MIP rods; pull and clean and plug boring with Benseal granules; load Geoprobe to move to location MIP-25 @ 5:05; set up Geoprobe @ MIP-25 location for probing tomorrow morning; dump decon water @ drain to treatment plant; sign out and leave site @ 5:30 and arrive @ hotel at 5:50. total time = 10 hrs

Mueller 9-27-11

Wednesday, September 28, 2011

Leave hotel ~~and arrive~~ @ 7:25 and arrive site @ 7:45; Rich (Mateco) on site; Doug (Columbia) on site; set up @ MIP-25 and begin pre-probing @ 8:05; weather - p. cloudy, 52°; hit the hard layer ~ 25 feet; softer @ ~ 32 feet; a little harder @ 52 feet; pre-probed

Mueller 9-28-11

Location Muskegon, MI Date 9-28-11
Project / Client Bofors

to 80 ft @ 8:35; pull and clean rods 9:00 am; begin MIP probing @ MIP-25 @ 9:05; looks like the conductivity probe became disconnected ~ 4 ft but will continue since we were mainly using that probe to see when we encountered the underlying till and we are not probing that deep anymore; around 20 ft cond went back up - it must not have had good contact with the soil between 4-20 ft; started getting hard around 23 feet; no response from any of the three detectors; very hard @ 26 feet; some ECD detections but relatively small; based on MIP probing, hard zone seems to be 23-29 ft; large ECD spikes in this zone and very little detection PID or FID; large ECD response (saturated) ~ 43-44 ft and PID up around 4 million μV - similar response to what we saw in MIP-15; stopped @ 65 feet as we have not had any detections on the three detectors for 10-12 feet; stopped probing @ 10:50; will pull and clean MIP rods; plug boring w/ Benseal granules; go to MIP-5 to plug that borehole then off to MIP-24 location; setup @ MIP-24; begin pre-probing @ 13:30; soft to 24 feet then a little harder but not like what we have encountered in the other borings; hard @ 73 ft (till?); stopped pre-probing @ 76 ft; pull and clean rods; 3.00 probe

Mueller 9-28-11

Location Muskegon, MI Date ~~9-28-11~~ 10-3-11
Project / Client Bofors

rods out and clean @ 14:20; begin MIP probing @ 14:30; stop @ 15:45 because the rig is heating up; determined that fan is not working; we are @ 63 ft and nothing detected; Dave went to get a portable fan to attempt to cool engine so we can pull the rods; conf call 4-5:10; Richard and Doug pull rods until 5:00; plug borehole w/ Benseal granules; meet @ Dave's office to discuss upcoming work; leave site @ 18:10 and arrive hotel @ 18:30.

total time = **10.5 hrs**

Mueller 9-28-11

Monday, October 3, 2011

Leave hotel @ 7:18 and arrive site @ 7:37; Doug (Columbia) called me @ 7:25 to inform me that he has a flat tire on the van and has to get that repaired before getting to the site; Rob (Matrix) arrives @ 8:00; will get setup @ MIP-23; pickup field equip @ Dave's office; finished pre-probing to 80 feet @ 9:25; Doug (Columbia) arrives @ 9:40; will pull and clean pre-probe rods; begin MIP probing MIP-23 @ 10:30; hard ~ 21-22 ft; slow MIP probing; down to 26 feet - very hard; started to get a little softer @ 28 ft; much softer ~ 37 ft; hard zone ~ 21 to 37 feet; very little to no response from detectors;

Mueller 10-3-11 weather - sunny, mid 50's

Location Muskegon, MI Date ~~10-3-11~~ 10-4-11

Project / Client Bofors

continued MIP boring to 65 feet; nothing detected so we stopped there; will pull and clean rods and move to MIP-21; broke rods trying to pull back up through hard zone; lost the tip and ~30 ft of rod; will try to retrieve when we have sonic rig on site next week; I flagged MIP-32 and 33 locations; Rob moves to MIP-21 location for pre-probing; Doug still working on getting new tip wired up; begin pre-probing @ MIP-21 @ 15:05; finished pre-probing @ 15:35; got a little hard ~65-70 ft but nothing like MIP-23; Rob and Doug leave site 15:50-16:00; conf call 16:00-16:30; meet w/ Dave then lock gate and leave site @ 17:05 and arrive hotel @ 17:20.

total time = 9.5 hrs

[signature] 10-3-11

Tuesday, October 4-2011

Leave hotel @ 7:22 and arrive site @ 7:40; Doug (Columbia) on site; weather - clear and cool, 40° - forecast is for a sunny day and a high of 70; Rob (Mateco) arrives @ 7:50; will pull and clean rods @ MIP-21; talked w/ Vince @ Mateco about drilling and well installation this weekend; pulled and cleaned rods until 8:40; begin MIP probing

[signature] 10-4-11

Location Muskegon, MI Date 10-4-11

Project / Client Bofors

@ MIP-21 @ 8:50; large FID response from 9-11 feet and from 36-50 feet; very easy probing - no hard layer here @ this location; no PID spikes and small ECD spike around 48 feet; to 65 ft @ 10:15 and no spikes for last 15 feet; will stop there and pull and clean rods; spoke with gas company and they will have a rep here @ noon to observe our drilling @ MIP-22; pulled and cleaned MIP rods at 10:40 and will wait for gas company rep before starting at MIP-22; plugged MIP-21 with Benseal granules; Ed Pawlowski of DTE Energy arrives @ 12:00 and gives us approval to drill MIP-22; begin pre-probing @ MIP-22 @ 12:10; stopped pre-probing @ 12:25 and no hard zones encountered; pull and clean rods; begin MIP probing @ MIP-22 @ 12:55; completed MIP probing to 70 feet @ 14:15; no spikes on any of the detectors; will pull and clean rods; increase in electrical conductivity around 69-70 ft - possible till?; plug hole w/ Benseal granules; move to MIP-28 location; pre-probe MIP-28 from 3:20-3:50; leave site @ 4:10 and arrive hotel @ 4:30. total time = 8.5 hrs

[signature] 10-4-11

Location Muskegon, MI Date 10-5-11

Project / Client Bofors

Wednesday, October 5, 2011

Leave hotel @ 7:25 and arrive site @ 7:45; Rob (Mateco) on site; will pull rods @ MIP-28 and then MIP probe; Doug (Columbia) arrives @ 8:05; weather - clear and cool, ~45° forecast of sunny and 70 today; pulled and cleaned rods until 8:45; set up and began MIP probing (MIP-28) at 8:50; hard zone from ~19 to 23 feet; FID spike @ 2 ft and ECD spike @ 22-23 feet, but otherwise nothing to 56 feet; down to 65 feet and no spikes; will stop @ 65 feet and pull and clean rods; plugged hole w/ Benseal granules and topped with asphalt patch; move to MIP-17 location; pre probe MIP-17; I go up to the office to coord getting the clay sample from the pit; I leave site @ 12:40 to pick up sample containers @ Trace Labs and then to Grand Rapids to collect clay sample; Doug and Rob will MIP probe at MIP-17; drove to borrow pit and collected grab clay samples for VOCs, SVOCs, PCBs, Pests, Cyanide and TAL metals @ 14:10; leave site and drop samples @ lab @ 3:25; back to site @ 3:40; hard zone from 21-28 feet and also hard @ 61 feet; no detector responses; will conduct a performance test after we pull

Sample CS (clay sample)

Mwalsh 10-5-11

Location Muskegon, MI Date 10-5-11

Project / Client Bofors

rods to make sure we are getting good readings; pretty hard @ 63 feet and still no response so we stopped there; will pull and clean rods; pulled and cleaned rods until 4:20; conf. call from 4-4:25; performance test showed that detectors are working fine; went with Rob to redevelop WC-275 and WC-27D; it appears that both wells have 10-20 ft of sediment in them; tried to pump one of them and the water was black and turbid; Dave said he could use his air compressor tomorrow to try to blow out the sediment; we will then come back tomorrow afternoon and pump them again; clean up, talk w/ Dave; leave site @ 17:45 and arrive hotel @ 6:00.

total time = 10 hrs.

Mwalsh 10-5-11

Thursday, October 6, 2011

Leave hotel @ 7:05 and arrive site @ 7:30; meet Todd Munger of Materials Testing Consultants to look for utilities; Rob (Mateco) arrives @ 7:40 and he will set up @ MIP 20; marked utilities; Todd leaves site @ 10:35 and I go down to MIP-20 location; top ~10 feet was hard but the rest is fairly soft and easy probing; PID response from 48 to 54 feet then back to baseline; did not hit the hard zone @ this location;

Mwalsh 10-6-11

Location Muskegon, MI Date 10-6-11

Project / Client Bofors

probed to 65 feet and did not see any other spikes; pull and clean rods; plug hole with Benseal granules; move to location MIP-30 (between tank farm and building 5) for next MIP; begin pre probing @ MIP-30 @ 13:20; pull and clean rods and begin MIP probing @ MIP-30 (blue) @ 14:15; hard zone ~ 22-25 ft then fairly soft; Dave came up to meet us and said he blew out all the sediment (lots of black soil and sand and several frogs) but they removed all sediment as his DOW measurements match pretty closely with the depths listed in the GIS. He did this by using an air compressor; large ECD spike @ MIP-30 from 22-24 feet; getting harder ~ 34 feet then softer again @ 36.5 feet; no PID or FID spikes and other than the ECD spike from 22-24 ft there were no other ECD spikes; stopped @ 64.5 feet; will pull and clean rods; since we are done MIP probing for the day, we went to the WC-27 well cluster to surge and pump the wells; plugged MIP-30 with Benseal granules; weather is sunny and very warm, low 70's; topped MIP-30 with asphalt patch; surged WC-27D and then pumped for 1 hour; pumped approx 200 gallons; pulled pump and cleaned with alconox and water wash and water rinse and will surge & pump WC-27S on Friday; leave site @ 6:18 and arrive hotel @ 6:35; total time = 11 hrs.

Mudrak 10-6-11

Location Muskegon, MI Date 10-7-11

Project / Client Bofors

Friday, October 7, 2011

Leave hotel @ 7:23 and arrive site @ 7:40; Rob (Mateco) and Doug (Colombia) arrive site 7:45; Rob drops surge block and pump @ WC-27S for me to re-develop later this morning; weather - clear 48°, forecast for sunny and low 70's; will pre probe @ location MIP-35 (western boring south of tank farm); begin pre-probing MIP-35 @ 8:35; pull and clean rods; begin MIP probing @ MIP-35 @ 9:55; at that point I go over to WC-27S and surge well with surge block for ~ 5 minutes then begin pumping well @ 10:08; conf call 10:30-12:00; stopped pumping @ 11:08 and went back to check on MIP probing; then back to continue pumping from 11:15-11:30; pull pump and cap wells; head back to MIP-35; pumped ~ 190 gallons from WC-27S and water was clear; @ MIP-35 hard zone was 19-24 ft; very high spikes on all three detectors - highest we have seen anywhere; pull and clean rods; plug hole w/ Benseal granules; cap hole w/ asphalt patch; MIP-35 was bored to 65 ft; set up and begin pre-probing @ MIP-36 @ 13:50; started MIP probing @ MIP-36 @ 14:25; Jack and Danny of Mateco arrive @ 2:50 for installation of the pump test wells; will get set up and start drilling today;

Mudrak 10-7-11

Location Muskegon, MI Date ~~10-7-11~~ 10-8-11

Project / Client Bofors

went back to check on MIP probing; a little hard from 17-22 ft @ MIP-36 but not as hard as MIP-35; down to 42 feet and no response on PID or FID detectors and a small ECD spike from ~17-18 ft then back to baseline; back down to PT well location - drillers setting up to drill; conf call 4:00-4:40; MIP-36 down to 65 ft and no spikes; stop there and pull and clean rods; did not have time to start drilling - will begin tomorrow; Mark McCullough arrived 4:55; we met with Dave; leave site @ 6:05 and arrive hotel @ 6:35; total time = 10.5 hrs

[signature] 10-7-11

Saturday, October 8, 2011

Leave hotel @ 7:25 and arrive site @ 7:40; weather - clear and ~60°, forecast is sunny and mid 70's; Jack, Neil and Rob (Matrix) on site; Fiori and McCulloch (NewFields); Doug from Columbia arrived @ 7:50 AM; Mark heads off with drilling crew to oversee PT well installation and I head off with other crew for MIP borings; set up @ MIP-34 and begin pre-probing @ 8:50; pull and clean rods; begin MIP probing @ MIP-34 @ 9:40; left to flag new (proposed) MIP locations;

[signature] 10-8-11

Location Muskegon, MI Date 10-8-11

Project / Client Bofors

flagged MIP-38 location; moved MIP-13 location east and that location is now 60 feet west of MIP-5 (could not get it @ 50 ft due to large trees); flagged MIP-27 location then went down to check on drilling; back up to MIP-34 location; stopped probing @ 65 feet @ 11:10; will pull and clean rods; PID response (below 500,000) from approx 27 to 31 feet, no FID response and ECD response from ~27 to 31 feet; detectors returned to baseline and stayed there; since we had some spikes but they were low concentrations we decided not to move west and do any more borings in tank farm area; will move south to MIP-32 location for next boring; @ MIP-34 there was a slight hard zone from 20-22 feet but not very hard; Doug and Rob will work @ MIP-32 location and I will go down to PT well location and start developing wells; plugged MIP-34 with Benseal granules and topped with asphalt patch; begin MIP-32 @ 13:10; hard zone 22-26 ft; PID and ECD spikes from 41 to 50 ft then approaching baseline; stopped @ 65 feet; will pull and clean rods; set up @ MIP-38 and will probe on Sunday; complete 6 shallow wells; Matrix folks leave site @ 16:30; me and Mark leave site @ 17:20 and arrive hotel @ 17:38; total time = 10 hrs (-2 hrs MAF sick time)

[signature] 10-8-11

Location Muskegon, MI Date 10-09-11

Project / Client Bofors

Left hotel @ 7:25 (Mark McCulloch - NewFields) Mike F. (NewFields) departed for airport. Weather is clear upper °50's, forecast for upper °70's.

Opened site @ 7:45. Rich (Probe), Jack, and Neall (drill crew) on-site today. Doug w/ Columbia will also be on-site today.

Planned work today includes 2 probes in wooded area, deep well for pump test, and well development. Drill crew will also install protective well casing at all pump test wells.

Drill crew break for lunch 11:30 to 12:30. Drill crew drilled and sampled to 50 feet at PT-5 Well set well after lunch. Developed PT-7 while crew setting up. Removed 65 to 70 gallons and completed stability test. Left site for lunch break 11:45 to 12:15.

During lunch break, Mark McCulloch went to MIP boring sites. Doug reported that preprobed to 80 ft at MIP-38. Encountered 'hard layer' between 29 and 34 feet bgs. Encountered another hard layer at 40 ft; refusal at 42. Did not want to risk breaking probe.

Called Mike Fiore at 12:30 to give ~~up~~ update for today.

Mark L McCulloch 10-08-11

Location Muskegon, WI Date 10-09-11

Project / Client Bofors

12:45 Drill crew began setting well at PT-5

3:00 PM Set piezometer at PT-5. Developed PT-4 ~~while~~ drill crew grouted annular space seal at PT-5. Also set still-wells at trench and pond. Left 3+ feet above ~~ground~~ surface water level; flagged w/ tape so visible. Drill crew also installing protective well casings at all pump test wells. Will cement in today too.

6:00 PM Drill crew finished cementing protective well casing in place @ 3:20. Began loading, de-contaminating drill tools etc., and preparing to leave site. Mark M. developed PT-6 and PT-3. Used down hole electric pump to develop all wells. Water was pumped to 275 gallon tote and moved to wells for development. Stability tests completed at each well while developing using ~~[illegible]~~ Horiba flow-through cell. 215 gallons pumped from 4 wells (PT-7, PT-6, PT-3, and PT-4)

~~[illegible]~~ Mark L McCulloch 10-08-11

Location Muskegon, MI Date ~~10-08-11~~ MSM 10-09-11

Project / Client Bofors

615 Drill crew left site. Mark M. locked both ~~gates~~ gates at end of the day. Will meet Geoprobe crew at 8:00AM Monday morning. Geoprobe operator (Rich) and Doug (Columbia) left site around 5:00PM after completing 2 MIP Borings. (MIP38 & MIP13) Hard zone 26 to 29, No readings/spikes (ECS @65) Drill crew checked load at front gate before leaving site. Left @ 645

Drill crew did NOT have time to overdrill at 2 MIP borings to recover lost probes.

Mark McCulloch 10-08-11

---

645 Unlocked gate east of ground water treatment building. Rick (Mateco) moving Geoprobe rig. Doug gave me MIP logs from yesterday. Will began first 2 MIP borings as soon as rig is ~~moved~~. Forecast; upper 50 (low) to upper 70's (high) Partly cloudy

930 Geoprobe advanced 'pre probe' boring @ MIP33 Dave leveled area @ MIP33; boring location flag was ontop of small berm, Dave also emptied tote containing purge water and returned empty tote for PT-1 and PT-2 development.

Location Muskegon, MI Date ~~10-09-11~~ MSM 10-10-11

Project / Client Bofors

12:00 Break for lunch. Completed MIP33 Boring. Will pull rods and move to MIP27 after lunch

12:30 Called and spoke w/ Mike over lunch Returned to the site.

15:15 Developed wells PT-01 and PT-02 75 gallons pumped from PT-01, and 70 gallons pumped from ~~PT-02~~. Completed stability test at both wells. Purge water placed in tote; Dave A. will pick up and discharge to treatment plant. Lab

1530 Geoprobe advanced preprobe to 80 feet at MIP27. Driller reported rock @ 45, but was able to advance probe to 80 feet. MIP probe hit refusal @ 45. Did not encountered hard layer with preprobe or MIP drill rods. Most likely refusal at rock.

1645 Doug (Columbia) and Rich (Mateco) left site, Plan to meet Tue a.m. after client conference call.

1715 Locked both gates after talking to Dave A. Clay berm under construction today; no more loads today, Dave will unlock

Mark McCulloch 10-10-11

Location Muskegon Date 10-10-11

Project / Client Bofors

gate Tuesday a.m. for trucks that will deliver clay.

500 F (NewFields)

Mike also called ~~to~~ let me know what time conference call will be. Will send email tonight to summarize results for today.

- Summary of MIP Probe Findings in Last 3 days

Day	Boring	Results
10/08	MIP32	Hard zone from 22 to 26 feet PID/ECD spikes from 41 to 50, then baseline measurement to EOB @ 65
10/08	MIP 34	Slight hard zone from 20 to 22 feet ECD/PID readings (spikes) from 27 to 31 (below 500,000) Baseline below 31 to EOB @ 65
10/09	MIP 38	Hard zone from 29 to 34 feet. Another hard zone @ 42 feet. Refusal @ 42 No significant ECD/FID/PID readings
10/09	MIP 13	Hard zone from 26 to 29 feet. No significant ECD, FID, or PID readings to EOB @ 65 feet.

Michael McCullough
10-10-11

Location Muskegon Date 10-10-11

Project / Client Bofors

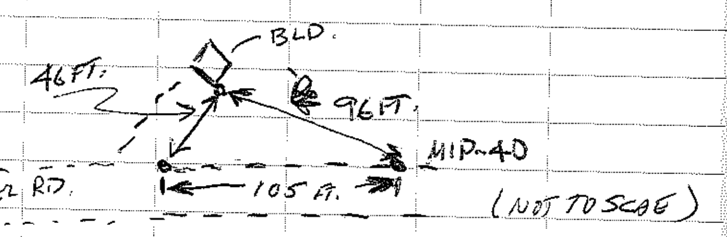
DAY	BORING	RESULTS
10/10	MIP 33 -	Hard zone from 29 to 32 ft. ECD, PID, or FID spikes between 48 and 54.
10/10	MIP 27 -	No hard zone encountered. Refusal at 42 feet. (most likely hit a rock).

sent info to Lindsay and Mike around 8:15 PM

Michael McCullough

Location Muskegon Date 10-11-11
Project / Client Bofors

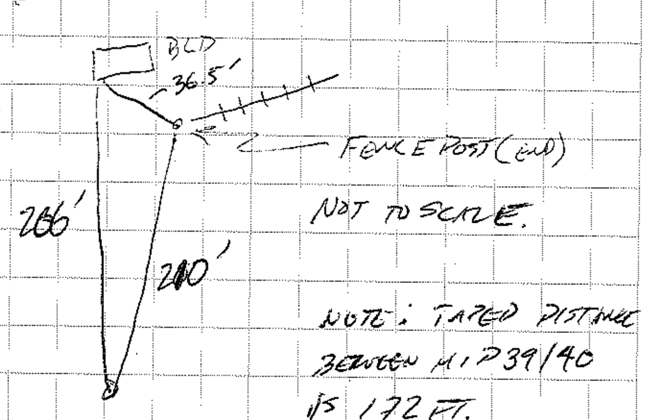
9:08AM Conference call w/ NewFields and USEPA re
935AM Arrived at site. USEPA agreed that toluene investigation for MW-111A is complete. NewFields suggested probes MIP-39 and MIP-40 prior to de-mobing crew; these borings ~~were~~ added to further characterize wet land area.
1200 Marked locations MIP-39 and MIP-40. Geoprobe 'pre probed' to 65 feet at MIP40, and will begin MIP boring soon. Plan is to finish MIP borings today (MIP39 & -40), and drill probe will de-mob on Wed. Well develop ~~wells~~ existing wells MW-62, WL-2A, and WL-2B on Wednesday before Geoprobe leaves site; will load Geoprobe rig and decon on Wed too.
145 EOB @ 60 at MIP40. Hard (slightly) from 41 to 49. Also hard (slightly) from 56 to 57. No response for ECD, PID, or FID. Will pull rod, decon, and move to MIP-39.



Mark L McCulloch 10-11-11

Location Muskegon Date 10-11-11
Project / Client Bofors

245PM Moved to MIP-39. Ready to begin 'pre probe boring'. 300PM Refusal @ 27' in preprobe boring. Moved 7' east.
430PM Developed P-5, and completed stability test. 80 gallons pumped (225 total from P-1, P-2, and P-5). Geoprobe advanced 'pre probe' boring to 80 feet. Very hard from 22 to 26 ft, ~~then~~ softer to 50. Hard to soft from 50 to 80 feet. Ready to begin MIP boring. Black sludge ~~on~~ on rods as removed from 'pre probe' boring. High conductivity readings between 10 and 15. Most likely drilled thru former lagoon.
~~MIP-40~~ MIP-39 Location.



Mark L McCulloch 10-11-11

Location Muskegan Date 10-11-11

Project / Client Bofors

600PM EC8 @ 62 ft at MIP39. No response for ~~[illegible]~~ MSM, PID, or FID. Hard zone (very hard) from 18 to 22 feet. Also hard below 58 feet. However, some response for ECD between 18 and 22'; same depth as ~~[illegible]~~ MSM ~~zone~~. hard zone.

645 Rich from Mateco left site after pulling and deconing all drill rod. Abandoned borehole with Benseal granular bentonite 35 to 40 lbs of 50 lb bag.

Doug (Columbia) is running post probe tests and finishing daily log. Will leave soon.

700 Doug (Columbia) and Mark (NewFields) left site. Weather today began in mid 50's and warmed up to Mid 70's. Sunny w/ few clouds.

Mark McCulloch 10-11-11

Location MUSKEGON Date 10-12-11

Project / Client BOFORS

740 Arrived at site; signed in at second gate. Opened second gate, but first gate unlocked. Trucks are delivering clay for berm construction.

800 Rich from Mateco arrived. Will decon and load Geoprobe rig.

Dave also stopped by. Reported that MW-62 was likely abandoned; it was crossed off his list (Parsons list)

Mark (NewFields) began re-developing wells WL-2A and WL-2B. Measured water levels and depth to bottom yesterday w/ Dave; Dave helped locate wells. Began pumping WL-2A @ 805 AM. Off at 8:55

1015 Rich from Mateco left site after deconing pump used for well development ~~WL-2B~~

WL-2B pump on @ 9:00; off at 9:50.

1030 Put padlocks on all 7 pump test wells. Locks are same key as locks used for gates. Will return keys to Mike F.

1145 Finished survey of all MIP boring locations to ensure ~~[illegible]~~ locations are flagged (for surveyor) 2 borings not abandoned (MIP8 and MIP23) due to lost probes. Could not find MIP27 or MIP37.

Mark McCulloch 10-12-11

Location Muskegon Date 11-12-11

Project / Client BOFORS

1200 Left Site. Spoke w/ Dave A. about site work
130 Returned PID and Horiba meters; shipped to rental company via UPS. Also went to hotel to check email and send email to Lindsay and Mike F. Weather today: Low to mid 30's in morning warming to mid 70's later today. Sunny w/ few clouds.

WELL DEVELOPMENT PROCEDURES USED FOR ALL WELL DEVELOPMENT WAS COMPLETED AS FOLLOWS:

- Surged for a minimum of 5 minutes w/ surge block provided by Mateco.
- Used down hole 2" submersible pump (whale pump) operated off 12 volt vehicle battery. Lowered pump to bottom of well and surged w/ pump for 1-2 minutes.
- Connected discharge line for pump to Horiba flow thru cell. Measured parameters (Temp, pH, ORP Specific Conductance, turbidity (NTU), and dissolved oxygen (DO)).
- Recorded parameters approximately 3 minutes until parameters stabilized and NTU fell below 5.0

Mark A McCulloch 10-12-11

Location Muskegon, MI Date 11-12-11

Project / Client BOFORS

MIP BORING LOCATION SURVEY

BORING	FLAG/LABEL	BORING	FLAG/LABEL
1	✓	21	✓
2	✓	22	✓
3	Not Drilled	23	NOT ABANDONED (LOST PROBE)
4	Not Drilled	24	✓
5	✓	25	✓
6	✓	26	✓
7	✓	27	✓
8	NOT ABANDONED (LOST PROB)	28	✓
9	NOT DRILLED	29	COULD NOT FIND
10	" "	30	✓
11	" "	31	NOT DRILLED
12	" "	32	✓
13	✓	33	✓
14	NOT DRILLED	34	✓
15	✓	35	✓
16	✓	36	✓
17	✓	37	COULD NOT FIND
18	NOT DRILLED	38	✓ ABANDONED TODAY
19	NOT DRILLED	39	✓
20	✓	40	✓

Mark A McCulloch 10-12-11

Appendix C: Standard Operating Procedures

SOP for Water Level/Non-Aqueous Phase Liquid Level Measurement

Job Description

Obtain a round of water levels and non aqueous phase liquid (NAPL) level (where applicable) at wells and piezometers.

Task-specific Equipment and Minimum Information Needed

- electric water level indicator or interface probe if NAPL is suspected
- paper towels
- hand-held engineer's measuring tape
- well location map
- well keys
- previous water level or water elevation data

Expectations

Water and NAPL levels will be taken at all the indicated wells and piezometers and recorded to the nearest 0.01 foot.

Document the time, date, and the method of the measurement.

Procedures for an Electronic Water Level Indicator

1. Uncap the wells and if the cap is not vented, allow the well to vent to atmosphere until the water level has equilibrated (time required will vary).
2. Carefully lower the tape into the well or piezometer.
3. The buzzer will sound as the probe hits the fluid. A solid tone indicates contact of the probe with NAPL and a beeping tone indicates contact with water. Once the buzzer has sounded, slowly pull the tape up {and down} until the buzzer turns off or the tone changes between solid and beeps.
4. Read the measurement from the top of casing and record it.
5. Take a second measurement to confirm, record it.
6. If groundwater samples are not to be taken, then measure the well depth by slowly lowering the tape to the bottom of the well. Note whether the well bottom is “soft” or “hard”. If groundwater samples are to be taken, then measure the well depth after the samples have been collected.
7. Decontaminate the tape before proceeding to the next well.
8. Replace the well cap.

Each time a water level or NAPL measurement is taken, a second confirmation reading is necessary to ensure that the water/NAPL level is stable. If the second measurement is within ±0.01 feet of the first, the measurement is good and can be recorded as a stable water/NAPL level. If the second measurement does not confirm the first, then wait for the well to stabilize and try again.

Indicate in your field notes if the measurements were taken after or during a period of rainfall. Be alert to any irregularities observed which may have an effect on the water levels (such as a nearby pumping well).

Always record the date, time and method of each measurement.

If the measurement references a "holding point" other than the top of the casing, or you are unsure of which point is the top of casing, indicate the reference point used, measure the difference between the top of casing and the reference point, and provide a diagram.

SOP for Vertical Aquifer Sampling (VAS)

Job Description

VAS will be conducted using either a GeoProbe with a four-foot long well screen or a hollow-stem auger rig with a temporary monitoring well and four-foot long well screen. Groundwater samples will be collected every eight feet from the water table down to the top of the till if using a GeoProbe and from the till upward to the water table surface if using a temporary monitoring well. The groundwater samples will be collected using low-flow procedures.

Several different methods can used to advance and retract the sampling tools. The method used will be dependent on accessibility to the sample location and type of materials being sampled. Sampling equipment can be advanced and extracted using impact hammers, hydraulic force, winches or hand driven methods.

Task-specific Equipment and Minimum Information Needed

- detailed well location map
- disposable gloves
- electric water level tape
- In-line multi-parameter water quality meter
- low flow (0.1 – 0.5 L/min), small diameter bladder pump and accessories
- sample tubing (dedicated); Teflon if sampling for SVOCs
- sample bottles
- cooler with ice to hold filled sample bottles
- container for purge water (if required)
- PID or FID for health and safety air monitoring

Procedures

Pre-Sample Collection

1. Locations of buried utilities will be checked and marked, as required by Michigan law;
2. The rig will be mobilized to the Site;
3. All sample collection equipment and supplies will be mobilized to the Site; and
4. Sampling equipment to be decontaminated per SOP for Field Decontamination.
5. Utilizing the appropriate PPE, drillers and technicians will mobilize to the sampling location;

VAS Groundwater Sampling using a GeoProbe

1. Using clean sampling equipment, the drillers will advance standard “GeoProbe-type” sampling rods to the top of till. A milled, slotted screen will be attached to the first sampling rod advanced in each location.

2. After the rods are driven (by the GeoProbe rig) to the target depth, the rods will be lifted approximately four feet to expose the screen.
3. Groundwater samples will be collected using a small diameter, submersible bladder pump and the SOP for low flow monitoring well purge and sampling. All samples will be preserved and placed in cooler with ice as per that SOP.
4. Water levels will be measured during purging to ensure that drawdown does not exceed 0.3 feet.
5. Data on the purge water, including purge volume, discoloration, odors and PID or FID readings will be recorded.
6. The pump and tubing will be decontaminated using the SOP for field decontamination. Instead of decontamination, dedicated tubing can be used for each sample. The Teflon pump bladder will be replaced as necessary.
7. The GeoProbe rods will be retracted 8 feet (i.e., four feet above the top of the previous temporary well screen interval) and the process will be repeated until the water table is reached.

VAS Sampling using a Hollow-Stem Auger Rig and Temporary Well

1. Using clean sampling equipment, the drillers will advance hollow stem augers fitted at the bottom with a knockout plug to the top of till. A four-foot long, stainless steel well screen will be attached to a sufficient length of either galvanized pipe or black steel pipe to reach from approximately 3 feet above ground level to the bottom of the boring.
2. After the temporary well is placed, the augers will be retracted to above the water table. The well will be allowed to stabilize for a minimum of four hours before the first sample is collected.
3. Groundwater samples will be collected using the SOP for low flow monitoring well purge and sampling.
4. The temporary well will be withdrawn 8 feet (i.e., four feet above the top of the previous temporary well screen interval), and the process will be repeated until the water table is reached.

Post-Sample Collection

1. After sampling has been completed for the hole, a tremie pipe will be lowered to the bottom of the augers and the boring will be grouted with thick bentonite slurry.
2. The drilling equipment (GeoProbe rods, augers, temporary well screen and riser) will be removed and decontaminated.
3. The rig will then be mobilized to the next sampling location.
4. At the end of each workday, the samples will be submitted to the laboratory for analysis. The samples will be analyzed by the laboratory for VOCs (Method 8260) and low level benzidine and 3,3`-dichlorobenzidine (L.L. 8270C).

SOP for Low Flow Monitoring Well Purge and Sampling

The objective in well sampling is to obtain a representative sample of the ground water from the formation where the well screen has been placed.

Job Description

Obtain ground water samples from the specified monitoring wells using low flow sample collection rates.

Task-specific Equipment and Minimum Information Needed

- detailed well location map
- order of the well sampling
- previous water level data
- disposable gloves
- total well depth data
- electric water level tape
- In-line multi-parameter water quality meter
- low flow (0.1 – 0.5 L/min) pump (bladder, peristaltic, electrical submersible, or gas driven pump and accessories)
- sample tubing (dedicated); Teflon if sampling for SVOCs
- sample bottles
- coolers and ice
- container for purge water (if required)
- well keys

Expectations

- All water levels will be measured prior to sampling (see SOP for Water Level/NAPL Measurement).
- All purge volume data will be recorded.
- Standard decontamination procedures (SOP for Field Decontamination) will be followed. Replace Teflon pump bladder if necessary.
- Noticeable discoloration or odor in the water will be reported.
- Each sample requested will be collected.

Procedures

1. Uncap all the wells of a cluster to be sampled. Care must be taken not to mix the caps up. The caps should be placed near the well on a clean area, such as a small piece of plastic. Inspect the condition of the well(s).
2. If the cap is not vented, allow the well to vent to atmosphere until the water level has equilibrated (time required will vary). Take a round of water levels, measuring and

recording static water levels. (Do not measure total well depth until after all samples have been collected.)

3. Purge the well using a clean, decontaminated pump. Locate the pump intake in the middle or slightly above the middle of the well screen interval. Avoid disturbing the water column more than minimally during purging. Purge water is to be contained and transported to the groundwater treatment plant for disposal.
4. The amount of water to be purged prior to sampling will be determined by monitoring water quality parameters. Parameters to be measured using in-line flow cells are: pH, temperature, specific conductance, ORP, dissolved oxygen, and turbidity. The well shall be purged until the water quality parameters have stabilized. Pumping rate, drawdown, and the time or volume required to obtain stabilization of parameter readings can be used as a future guide to purge the well. Measurements should be taken every three to five minutes. Stabilization is achieved after all parameters have stabilized for three successive readings. In lieu of measuring all five parameters, a minimum subset would include pH, conductivity, and either turbidity or DO. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 10 mv for redox potential, and ± 10% for turbidity and DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen and turbidity usually require the longest time for stabilization.
5. Record the amount of water actually purged and what was done with the purge water. Record the method of purging, and the pump used.
6. Collect the ground water sample with the pump at a rate not exceeding 500 ml/minute. VOCs are not to be sampled using a peristaltic pump.
7. Fill the sample container(s) accordingly.
8. Seal the container.
9. If the container is a VOC vial, fill the vial completely until a convex meniscus is formed at the top of the vial and cap quickly so that the vial contains no headspace. Turn the full container upside down and tap it lightly. Watch for air bubbles. If air is present in the bottle, discard and resample the well.
10. Label the sample bottle(s) and place in a cooler with ice for transport to the laboratory.
11. Follow standard decontamination procedures. Replace tubing used with the pump(s) after each use, and replace the short length of internal silicone tubing in the peristaltic pump after each use. Completely disassemble the bladder pump and carefully decontaminate after each use. Replace the Teflon bladder if necessary.

Reference: Puls, R. W. and Barcelona, M. J., 1996, "Low-Flow (minimal drawdown) Ground-water Sampling Procedures," Ground Water Issue, United States Environmental Protection Agency, EPA/540/S-95/504 April 1996.

SOP for Field Decontamination

Decontamination Frequency
All equipment to be decontaminated is to be decontaminated after each use in the field.

Upon Arrival at Site
Equipment which has not been pre-decontaminated and suitably protected before and during transport to the site should be decontaminated prior to initial use.

Field Decontamination Procedures
The procedures for decontamination in the field are as follows:

Steam cleaning followed by wash and rinse: for the drill rig, Geoprobe sampling equipment, bladder pump, solids sampling implements, and temporary interstitial water sampling well casings and screens.

Wash and rinse: for analytical probes and nondisposable labware. The order of decontamination will be Liquinox wash, tap water rinse, and deionized water rinse.

All disposable gloves will be discarded between samples. All disposable clothing will be placed in drums on site. All one-time sampling equipment (e.g. tubing, bailers) will be disposed to an on-site drum after use.

Steam and Steam Cleaning Water
Tap water is typically used for steam cleaning. Steam cleaning should always be done at "live steam" temperatures, which exceed 212ºF. Be sure the steamer water is taken from a public water supply or a source of known and approved quality. If you know or suspect that unvaporized water is carrying over, halt work until the steamer is performing as it should or use an alternative decontamination method. Also, be sure the steam delivery wand is of sufficient length to deliver live steam to any remote points of the equipment.

On-site Storage and Disposal of Decontamination Fluids
All spent wash and rinse waters along with other incidental waters such as well development or well evacuation water are to be contained. All water wastes are to be taken to the on-site treatment facility.

SOP for Field Screening of NAPL in Soil with Sudan IV Dye

Scope and Application

Soil samples collected as part of the vertical aquifer sampling program will be screened for the presence of light or dense non-aqueous phase liquids (LNAPL or DNAPL) using the Sudan IV dye test.

Equipment

- SUDAN IV Test kit or approved equivalent
- Nitrile gloves
- Sample containers or baggies
- Field notebook
- Waterproof pen

Procedure

In a sample container or baggie, add the following:

- 2 - 5 mg of soil
- 2 ml of water
- Approximately 1 mg of Sudan IV dye

Agitate/shake the container or baggie.

If LNAPL is present, it will appear as floating red droplets or as a floating red layer colored by Sudan IV.

If DNAPL is present, it will appear as a red layer or red droplets at the bottom of the container.

In the field notebook, record the following:

- Depth interval of the soil sample
- Proximity of the soil sample to the water table
- Soil type
- Results of Sudan IV dye test

If disposable sample containers or baggies are used, the entire sample will be disposed of as investigation derived waste (IDW) in a drum on-site to be buried under the soil cap upon completion of investigation activities.

If reusable sample containers are used, the contents will be disposed of in the IDW drum, and the container will be decontaminated in accordance with the SOP for Field Decontamination.

SOP for Monitoring Well Construction and Development

Part 1 - General

1.01 Description

A. Contractor is referred to the Owner's Construction Contract and will consider same as a part of these Specifications as if repeated herein.

B. Contractor shall review all other Sections of this Work Plan for instructions related to work under this standard operating procedure (SOP).

C. Groundwater monitoring well(s) are to be installed at the site in the location(s) shown on the work plan figures.

D. The wells shall be constructed with a borehole, PVC riser, screen, sand pack, bentonite seal, grout seal, locking top cap, and a protective ground box or protective outer casing, as detailed in this SOP.

1.02 Submittals

A. Installer: Submit the name and address of the proposed well drilling contractor, a completed contractor pre-qualification questionnaire and a list of at least five completed projects of similar construction.

B. Well Log Data: The Contractor shall provide screen size and length and details of well construction for all of the wells and piezometers for inclusion on the well logs.

C. The Owner will hire a surveyor to provide elevation and coordinate information.

Part 2 - Products

Protective Outer Casing

A. The groundwater monitoring wells will be located within a protective casing pipe that shall be constructed of flush threaded, Schedule 40 carbon steel pipe.

Top Caps

A. A plastic expandable, water infiltration resistant, cap with lock shall be provided for the casing at the top of each groundwater monitoring well. All locks are to be keyed alike.

Riser

A. The riser pipes for the monitoring wells shall be of schedule 40 PVC. The riser pipe diameter and schedule shall be two inches. All riser pipe and well screen threading shall be fully compatible.

Screen

A. The screen for monitoring wells shall be flush jointed, threaded, Type 316L or type 304 stainless steel pipe with a threaded Type 304 stainless steel bottom plug. The screens for the monitoring wells will be 0.007”, manufactured of continuous wire wrapped construction. All riser pipe and well screen threading shall be fully compatible. Screen length is to be determined based on the purpose of the well(s). Wells constructed for chemical analysis shall have 3-foot stainless steel screens. Wells constructed for piezometric data collection only can have longer screens of PVC.

Sand Pack

A. The sand pack surrounding the well screen shall be appropriately sized, washed, clean silica sand. The grain size of the sand will be such that less than 5% infiltration of the screen (by the sand) will occur (U.S. Silica #00 or equal). See detail for sand pack sizing. A one-foot thick rock flour (choke sand) layer will be placed atop the sand and between the sand and bentonite seal.

Bentonite Seal

A. A minimum of two feet of bentonite chips will be placed into the annular space of the well boring, above the sand pack. Care will be taken to ensure that the chips do not bridge upon placement. Methods to inhibit bridging will include utilization of vibrating devices to “compact” the seal, utilization of careful methods of placement (tremie pipe, etc), or other methods approved by the Owner’s Construction Manager. If the seal is installed in unsaturated conditions, the chips will be hydrated by the addition of five gallons of potable water to the borehole.

Grout Mixture

A. The grout mixture for the monitoring wells shall be a mixture of Type I, ASTM C150 Portland Cement (1-94 lb. bag), minus No. 200 sieve bentonite powder (5 lbs.), and clean potable water (9 gallons).

Bollards

A. Bollard will consist of Galvanized Steel Pipe, 4 inches diameter, standard weight (Schedule 40).
B. The pipe will be filled with 3000 psi concrete and painted with Rust Oleum Primer: No. 3202 and a Finish Coat of New Color Horizons, No. 944 (Safety Yellow) or equal.

Part 3 - Execution

3.01 Well Installation

A. Monitoring Wells: The new groundwater monitoring well(s) shall be installed at the location(s) shown on figures in the work plan. Vertical aquifer sampling or membrane interface technology shall be conducted to determine the well depth and screen placement. The new well boreholes shall be advanced using hollow stem auger or Geoprobe sonic drilling techniques. After each borehole is advanced to the target depth, the wells will be constructed within the borehole. The screen and riser, along with bottom plug and top cap will be placed into the borehole. The sandpack and bentonite seal will then be layered into the annular space between the well string and the borehole. The drill string will be removed, slowly, as the sandpack and bentonite is added to ensure than the borehole does not collapse. If heaving sands are encountered, a bottom plug may be used in the drill string. Anticipated well depths and intervals to be screened are to be determined. Sand pack shall be installed from the bottom of the borehole to two feet above the top of the screen. The bentonite seal shall be placed above the sand pack and shall be a minimum of two feet thick. All cuttings and drilling materials shall be disposed in the lagoon area beneath the soil cap. Drilling equipment shall be decontaminated prior to drilling, between boreholes, and before leaving the site.

B. Monitoring Well Construction: Following completion of the drilling, a well shall be constructed. Each well shall be constructed with threaded, Schedule 40, flush-joint riser with 0.007-inch slot continuously wire wound screen. The annular space between the well screen and borehole wall shall be backfilled with clean silica sand. The sand pack shall extend to two feet above the top of the well screen. Bentonite chips shall be placed above the sand pack to form a minimum two-foot thick seal. A cement/bentonite grout or a bentonite slurry shall be installed above the bentonite seal to the surface. Each well shall have a vented cap and a steel casing with a hinged locking cap placed over the well. The protective casing shall extend at least two feet above the ground surface and be cemented in place. The cement seal or pad shall be sloped to channel water away from the well. A permanent measuring point, which shall be surveyed to within + or - 0.01 foot of vertical and 0.1 foot horizontal by a Michigan State licensed land surveyor, shall be marked on the riser, by cutting a “notch” into the riser. Installations shall be overseen by the field Geologist and recorded in the field book.

C. Well logs will be prepared by the Geologist on-site. The Contractor shall provided screen size and length and details of well construction for all of the wells for inclusion on the well logs.

D. A surveyor will be hired to provide ground surface and top of casing elevations and coordinate information for each well.

E. Pipe bollards will be placed around well clusters as directed by the on-site Geologist. The pipe bollard shall be set in the center of the hole and braced plumb. The annular space around the pipe shall be filled with concrete and the pipe filled with concrete. Dome the concrete above the top edge of the pipe to shed water. Remove braces after concrete has set. Apply one coat of primer and one coat of finish paint in accordance with the manufacturer's printed instructions.

3.02 Well Development

A. Monitoring wells will be developed. Well development shall be performed after the grout seal has set for a minimum of 48 hours. Initially the static water level and total well depth from the top of riser shall be measured. The wells shall be pumped to remove sediment from the well screen and sand pack. Well evacuation shall be accomplished using a positive displacement pump and dedicated polyethylene tubing equipped with a foot valve, or a submersible pump. Well surging for monitoring wells shall be completed with a surge block. Dedicated tubing shall be used to eliminate the need for decontamination and reduce the risk of cross contamination. The Contractor shall attempt to develop the wells until the pH, conductivity, dissolved oxygen and temperature of the water in the well stabilizes. The well development shall be overseen by the on-site Geologist. Measurements should be taken every three to five minutes. Stabilization is achieved after all parameters have stabilized for three successive readings. Three successive readings should be within ± 0.1 for pH, ± 3% for conductivity, ± 0.2 for temperature and ± 10% for DO. Stabilized purge indicator parameter trends are generally obvious and follow either an exponential or asymptotic change to stable values during purging. Dissolved oxygen usually requires the longest time for stabilization. During development, the minimum and maximum well volumes to be removed will be 5 and 20, respectively.

B. The well development water shall be contained and transported and discharged to the Groundwater Treatment Plant at a flowrate determined by the Owner's Construction Manager.

3.03 Acceptance

A. If at any time during the installation of a well, the on-site Geologist determines that the well has not been properly installed, the Contractor shall abandon the hole and slurry grout its full depth as directed by the Engineer and initiate construction of a new well at a location determined by the Engineer at no cost to the Owner.

B. Upon completion of a well, the Contractor shall demonstrate to the on-site geologist that the full depth of the well is free from any obstructions and clear of any formation materials and that the well will produce clean sediment-free water, or the well shall be deemed unacceptable and shall be abandoned and re-drilled.

SOP for Extraction Well Construction and Development

Part 1 - Background Data

1.01 Work Scope Overview

A. One extraction well will be constructed in the vicinity of the PZ-111 well cluster at the Bofors Nobel Superfund Site (the Site).
B. The extraction well will be installed to recover toluene-contaminated groundwater outside of the barrier wall on the western portion of the site.
C. The extraction well will be constructed using 8-inch diameter, stainless steel wire-wound well screen and PVC riser.
D. The well will be provided with appropriate sand pack, bentonite seal, cement-bentonite grout, a lockable steel outer casing and a concrete pad.
E. The well construction methodology and specific well-construction details are provided below.

1.02 Questions Regarding SOP

Any questions regarding the scope of work described in this document should be addressed to:

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NewFields
P.O. Box 480309
Charlotte, North Carolina 28269
(704) 358-0744 (office), (704) 607-7469, (704) 358-8196 (fax)
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OR

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Project Scientist
NewFields
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Altanta, Georgia 30309
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Part 2 - Scope of Work

EXTRACTION WELL LOCATION

Extraction well PW-111 will be a new pumping/recovery well located approximately 220 feet south of the PZ-111A monitoring well, outside of the barrier wall and along the fenceline on the western portion of the site. Access to the well site will be constructed by Precision Pump.

2.2 EXTRACTION WELL CONSTRUCTION

Extraction well PW-111 will be constructed of 8-inch diameter, 10-slot (0.010”), wire-wound, 304 stainless steel screen and Schedule (Sch) 80 PVC riser. The screen slot size may be revised after a grain size analysis is performed on the soil.

The screen length will determined subsequent to review of vertical aquifer sampling (VAS) results but is assumed to be 20 feet (screened from 45 to 65 feet below ground surface (bgs)) based on results of membrane interface probes (MIPs) in the area. The total depth of the well is estimated to be 65 feet bgs. The well will have a locked steel outer casing and a concrete pad.

The construction of the extraction well consists of installation of a soil boring, installation of the well components, development of the well, and decontamination of the equipment (see the SOP for Field Decontamination).

The following methods will be used for drilling the borehole and installing the extraction well:

- The well will be installed in a minimum 12-inch diameter boring. The drilling method will be determined subsequent to VAS drilling/sampling and will consist of either hollow-stem auger or sonic drilling techniques. If it is perceived that the formation will produce flowing sands or other obstacles to setting the extraction well then mud-rotary drilling may be used. Overdrilling to ensure that the well reaches the proper depth is acceptable.
- The boring will be completed straight and plumb and the alignment will be checked from top to bottom (in accordance with standard industry practice) before well installation.
- During well installation, the screen and riser pipe will be centered in the borehole using centralizers.
- The well will be constructed using 20 feet of 8-inch diameter, wire-wound, 304 stainless steel screen with 0.010-inch slots (10-slot screen). Please note that soil samples will be collected during VAS and a grain size analysis will be performed to determine screen slot size and sand pack and as such, the proposed screen size may be reduced to a 0.007-slot size screen if necessary.
- The riser pipe will be constructed of Sch 80 PVC and extend to approximately 2 feet above ground level.

- A permanent measuring point, which shall be surveyed to within + or - 0.02 foot of vertical and 0.1 foot horizontal by a Michigan State licensed land surveyor (survey not part of Scope), shall be marked on the riser, by cutting a "notch" into the riser.
- A fine-grained filter sand, equivalent to a U.S. Silica (Morie) #0 sand, will be placed from the bottom of the well screen to three feet above the well screen. The filter pack sand size may be changed pending evaluation of the grain size analysis results and screen slot size.
- A two-foot thick bentonite chip or pellet seal will be placed above the filter pack.
- The remaining annular space will be filled with a cement-bentonite grout. The grout will be placed using a tremie pipe placed near the bottom of the annulus. Once the annular space is filled with grout, the tremie pipe will be withdrawn and the annular space topped off with grout.
- A protective steel outer casing pipe shall extend approximately 2.5 feet below ground level and 3 - 6 inches above the top of the inner casing, and shall be cemented in place. The total length of the outer casing will be approximately 5 feet.
- The cement seal or pad shall be 2' by 2' by 1'deep and shall be sloped to channel water away from the well.
- The extraction well will be developed per the procedures detailed in the section below.
- All drilling and development water will be containerized and transported to the onsite treatment plant.
- At completion, the depth of the recovery wells will be measured and recorded by the Contractor (Mateco).
- Split-spoon samples will be collected continuously from the ground surface to the top of the till during VAS activities. Therefore, split-spoon samples will not be collected during drilling for the extraction well as the extraction well boring will be advanced in close proximity to the VAS boring.
- All drilling equipment will be decontaminated prior to entering the site and will be decontaminated prior to leaving the site. Decontamination will be conducted in accordance with methods specified in the SOP for Field Decontamination.
- The field geologist will record borehole geology.
- After the well is constructed, it will be secured with a padlock.

2.3 EXTRACTION WELL DEVELOPMENT

- Well development shall be performed after the grout seal has set for a minimum of 48 hours.

- The extraction well will be developed by jetting with a jetting tool. Development using a surge block is also acceptable. Development will proceed from the bottom of the well to the top of the well screen until the discharge water is clear and free of sediment. At the end of development, the well will be pumped to remove sediment from the bottom of the well.
- The well will be developed until the water in the well is reasonably free of visible sediment (50 NTU if possible). A portable nephelometer (turbidity meter), supplied by NewFields, will be used to make this measurement. If the turbidity standard cannot be reached in a reasonable amount of time, the wells will be considered as developed when three successive readings are within ± 0.1 for pH, ± 3% for conductivity, ± 0.2 for temperature and ± 10% for DO. A portable meter(s), supplied by NewFields, will be used to make these measurements.
- Water level measurements will be taken before and after development.

2.4 WASTE DISPOSAL

- All waste soil derived from soil sampling, boring, or geoprobe will be transported by Precision Pump and disposed of beneath the on-site landfill cap.
- Personal protective equipment (PPE) will be stored in a drum on site for later disposal.

2.5 FIELD DECONTAMINATION

- All equipment to be decontaminated is to be decontaminated after each use in the field.
- Equipment which has not been pre-decontaminated and suitably protected before and during transport to the site should be decontaminated prior to initial use.

The procedures for decontamination in the field are as follows:

- An existing concrete decontamination pad exists on site. If this pad does not meet the need of the drilling contractor, he will construct a decontamination pit at a location designated by the observing geologist/engineer. Decontamination water will be transported and disposed at the Groundwater Treatment Plant by Precision Pump.
- Steam cleaning followed by wash and rinse: for hand augers, Geoprobe sampling equipment, bladder pump, solids sampling implements, and temporary interstitial water sampling well casings and screens.
- Wash and rinse: for analytical probes and nondisposable labware. The order of decontamination will be Liquinox wash, tap water rinse, and deionized water rinse.

- All disposable gloves will be discarded between samples. All disposable clothing will be placed in drums on site. All one-time sampling equipment (e.g. tubing, bailers) will be disposed to an on-site drum after use.
- Tap water from an on-site source will be used for steam cleaning.
- Steam cleaning should always be done at "live steam" temperatures, which exceed 212ºF. If unvaporized water is carrying over, work will be halted until the steamer is performing as it should or an alternative decontamination method will be used
- The steam delivery wand will be of sufficient length to deliver live steam to any remote points of the equipment.
- All spent wash and rinse waters along with other incidental waters such as well development or well evacuation water are to be contained. All water wastes will be transported by Precision Pump to the on-site water treatment facility.

2.6 HEALTH AND SAFETY

The drilling contractor (Mateco) will be responsible for developing and implementing a site specific health and safety plan (HASP). The following site-specific information is made available from the current on-site HASP to assist the contractor with developing a HASP.

Hazardous materials, hazardous substances and/or hazardous wastes may be present at this Site. Subcontractor must furnish written evidence that Subcontractor's employees, who are assigned to work at this site, have received OSHA 40-hour hazardous waste operations (HAZWOPER) training, related field training and annual up-dates as required in 29 CFR 1910. Subcontractor personnel who do not have appropriate, current OSHA training certificates shall not be allowed on site. In such cases, Subcontractor will not be reimbursed for delays and other costs associated with Subcontractor's failure to provide personnel with required training.

Emergency Contacts

In the event of any situation of unplanned occurrence requiring assistance, the appropriate contact(s) should be made from the list below. For emergency situations, first dial 911. Then contact should be made with Field Team Leader (or designee) who will notify emergency personnel. The emergency personnel can then contact or coordinate with the appropriate response team(s). This emergency contacts list must be in an easily accessible location at the Site.

Contingency Contacts	Phone Number
Ambulance	911 or (231) 722-6601
Fire Department:	911 or (231) 724-6792

Police: 911 or (231) 724-6750

<u>Medical Emergency</u> Information is provided on three local medical facilities. The facility referenced in the previous USACE HASP is the facility located on E. Sherman Blvd.

Hospital Name and Address	Mercy General Health Partners 1700 Oak Ave Muskegon , MI 49442-2407 (231) 773-3311	Mercy General Health Partners PO Box 358 1500 E Sherman Blvd Muskegon , MI 49443-0358 (231) 739-9343	Hackley Hospital PO Box 3302 1700 Clinton St Muskegon , MI 49443-3302 (231) 726-3511